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DEVOTED ESPECIALLY TO THE STUDY OF FUNGI IN THEIR RELATION TO PLANT DISEASES.

EDITED BY

THE CHIEF AND HIS ASSISTANTS.

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RECENT INVESTIGATIONS OF SMUT FUNGI AND SMUT DISEASES.

AN ADDRESS DELIVERED BEFORE THE SOCIETY OF AGRICULTURISTS OF BERLIN, FEBRUARY 17, 1888.

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[Translated from *Nachrichten aus dem Klub der Landwirthe zu Berlin*, Nos. 220–222, by Erwin F. Smith.]

GENTLEMEN: About four years ago, in January, 1884, I found opportunity in this place to report the new researches which I had completed upon the smut fungi, the *Ustilagineæ*. To this first communication I will to-day add a continuation explaining the results which I have obtained since my last address.

In nature the smut fungi live as parasites, in a multitude of forms. We find them universally distributed on the most dissimilar plants, but most frequently upon our cultivated plants and among these, especially, upon the different cereals. The usually striking and ruinous destructions which they produce in the host plants, and especially in the fruit-bearing portion, the spikes and panicles of grain, have been known and feared by farmers for a long time, under the name of smut diseases, or the phenomena of grain smut. The grain smuts belong without doubt to those plant diseases which operate most destructively, in that they destroy the chief aim of cultivation, the grain itself. For this reason first of all they have a very just claim to the most exact research for their recognition and prevention.

As a matter of fact, researches on the smut fungi and observations and experiments on the appearance and prevention of smut diseases have been made repeatedly for a long time and have often claimed

attention. Keeping step with further knowledge and experience in mycology they are always taken up afresh whenever any new suggestions or new views for further enlightenment open up, and whenever new methods of research show new points for attack.

In this way, then, my researches on the smut fungi and diseases, begun about eight years ago, were only the natural continuation of the labors of earlier authors; except that they were accompanied by other and fresh thoughts and supported by methodical expedients such as previously had not found employment, nor, indeed, could find it. They were begun after a long stand-still in observations on smut fungi and smut diseases, and when renewed experiments with the worn-out thoughts and methods would give no new and substantial results.

Till my experiments everybody proceeded upon the supposition that the fungi existing parasitically in nature found their natural conditions of existence only upon their hosts, and therefore that the different smut fungi could live and grow only upon the different but definite and restricted host plants, on which they were observed in the open air. Accordingly it was very evident that experiments and observations must be confined to the host plants; that in order to investigate the connection of fungus and disease, the fungous germs, found on the host plants, consequently the smut spores, must be sowed again upon the host plants and their development followed. The idea was so simple and natural that candid minds did not suspect the confusion of perception and judgment which this thought naturally carried with it.

Upon the host plants the smut spores find, first, only moisture for their development, consequently they must germinate on the surface of the plants just as they germinate in a small drop of water. Now, germination experiments with smut spores in water have shown most convincingly that the spores in many cases, *e. g.*, in corn smut, do not germinate; that in other cases they germinate only in small numbers and very imperfectly, *e. g.*, in oat smut and millet smut. From these negative or at least imperfect results of germination in water, which results were to be observed in just the same way upon the surface of the host plants, the universal distribution of the fungi in question and of the smut diseases in grain could be explained only very imperfectly or not at all. Nevertheless, these explanations gave satisfaction, the rudimentary consistency of facts was regarded as complete, and to no mycologist did it occur that any one would succeed in acquiring new information or in making a very important advance in the knowledge of smut diseases.

My culture methods for the investigation of fungi, were slowly and painfully established and brought to gradual completion during the long period of more than sixteen years, and meanwhile put to use, alike in the minute schizomycetes and the great mushrooms, in the simplest as well as the most highly developed fungous forms, with similar trenchant results for knowledge of the developmental history of fungi. These

led me, in their further perfection, gradually to results which made the difference between fungous forms that maintain themselves as parasites on living plants and animals, and such as live only as saprophytes on dead organic substances, appear less sharp than, according to the common state in nature, it was believed to be. I succeeded artificially, with my nutrient solutions, in growing fungous forms as luxuriant as were to be observed in nature on the host plants, and in some cases much more luxuriant, *e. g.*, *Peziza ciborioides* and *P. sclerotiorum*, which in nature are found living on clover and rape; also, *Sphacelia segetum*, the fungus of ergot, and many others. This itself led me to considerations on *the nature and reality of parasitism and on the way in which the various parasitic phenomena in nature might come about.* These observations always led only to the one reasonable conclusion, *that parasitism can be nothing else than a form of existence which has become more or less suited to the fungus according to the length of time, and differently and specifically adapted to it in each individual case, but which, for all that, has become by no means constant.* It was only the natural consequence of these trains of thought, based upon observations in nature, and upon the results obtained in my culture experiments, to draw this conclusion: *Even in the most distinctly marked cases of parasitism, in which the fungus is found only on given plants or even on particular portions of these, nothing else is before us except the furthest extended phenomena of the same adaptation, which by its more developed form produces the* OUTWARD APPEARANCE, *as though the natural conditions for the existence of these parasites were given exclusively in the living substratum, consequently in the particular host plants, or special portions of these, and as though every other way of life and growth were altogether excluded.*

And by this outward appearance all mycologists were obviously captivated, until my investigations. No botanist had thought of critically examining the essential nature of parasitism, of following out naturally the sole possible origin of parasitic phenomena, and of making it clear in what way the whole multitude of its variations is simply and naturally subordinate to one unifying thought, *a thought which included in itself not only the possibility but also the probability that fungi living parasitically—at least the greater part, if not all of them—can live outside of the host plant.*

When, almost ten years ago, I gave publicity to my views on parasitism along with my culture methods, and at the same time expressed strong confidence that unquestionably it must be possible artificially to cultivate most, if not all, parasitic fungi, my views remained not only generally unconsidered, but were in special cases, in the *Botanische Zeitung*, even scornfully criticised. This circumstance shows, as no other, the confused judgment of mycologists upon parasites and parasitism, and enables one to measure clearly the difference between the old sterile ideas and the new fruitful thoughts. Only this confusion of ideas, which must be plain upon considerate reflection, could have prevented

the earlier mycologists from at once *striking into the broader way for the investigation of parasites, the method of cultivation in artificial nutrient solutions instead of in mere water.*

As great as the fundamental difference in ways of thinking and methods which separates the earlier and the present investigations, so great is the difference in the results obtained, as I shall now show more explicitly in further experiments with the smut fungi.

Even in my first address on smut fungi and smut diseases, in 1884, I communicated important and unexpected results which I had then reached in cultivating different smut spores in artificial nutrient solutions.* While *in mere water* the smut spores either did not germinate, *e. g.*, the spores of corn smut, or germinated only scantily and concluded their development with the formation of a short germ tube (promycelium) and a few germ cells (conidia or sporidia); the same spores germinated *in nutrient solutions* without exception, the germ tubes produced conidia in inexhaustible abundance,† which only grew out into germ tubes when the nutrient solution was exhausted. The conidia were of definite shape and size, therefore specific for the individual forms of the smut fungi. In a number of forms they were produced *under liquid*, *e. g.*, in *Ustilago carbo*, *U. cruenta*, *U. maydis*, which are known as oat, millet, and corn smut; in other forms they were produced above the liquid *in the air*, *e. g.*, in the stone smut of wheat, *Tilletia caries*. In this fungus and the forms related to it there grew further in nutrient solutions, out of the conidia derived from spore germination, large, richly branched mycelia, which again produced the same conidia in unlimited abundance as short lateral shoots; *there arose, in fact, mold-like turfs*, which were again produced out of the new-formed and again new-sowed conidia, always in the same manner and abundance, so long as the culture was maintained in the nutrient solution. In oat, millet, and corn smut, and forms closely related to these, the further development of the conidia produced by spore germination under the nutrient solution continues not mold-like, but quite otherwise. *The conidia of definite size and shape produced on the short germ tubes of the smut spores multiplied in just this size and shape by direct sprouting at definite places, and that always at both ends, in a rapid manner, without limit.*

Furthermore, the sprout-colonies of conidia which were so produced,

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* Additional cultures with parasites selected at random resulted in showing that in almost all cases maintenance outside of the host plant is easy to accomplish; even the lichen forming *Ascomycetes*, which live on and with different algæ, representing the so-called lichens of nature, could be easily cultivated "without algæ" in my nutrient solutions with the help of my culture methods, as final valid proof that lichens are nothing but a number of *Ascomycetes* which live parasitically on different algæ. *Vide* Möller, *Kultur flechtenbildender Ascomyceten ohne Algen.* Arbeiten aus dem botanischen Institute in Münster i. W., 1887.

† For those who only read my address and have not seen the accompanying illustrations on the wall charts, I refer to the tables in my book *Brandpilze* I.

and which easily separated into their individual members, enabled us to recognize in the different forms of smut fungi, to which they belong as stages of the development, a different but always definite and typical appearance, depending on the form and size of their conidia. Thus, for example, the sprout conidia in oat smut (*Flugbrand*) were produced from the long egg-form conidia of this smut; the sprout colonies of the corn smut were made up of the longer somewhat spindle-form conidia, peculiar to this smut fungus; the sprout aggregations of the millet smut had the narrow spindle form of the conidia of this fungus. Even in the different species of the smut genus *Ustilago*, investigated four years ago, there were found "as characteristic stages of the development," just as many specific and different sprout forms as are found round to elongate conidia of the various sizes.

In their appearance and in their growth by sprouting these aggregations of conidia in the smut fungi are also similar to the large number of those long-known fungous forms which, from their characteristic growth and increase by so called sprouting, it has been thought necessary to consider as specific forms, and also to specially distinguish as SPROUTING FUNGI. They also show themselves fully consonant with the previously known sprout fungi in that, like them, they continued sprouting indefinitely, so long as they vegetated in congenial nutrient solutions; and in that they always remained in sprout form, consequently staid sprouting fungi, and passed over into no other form, only at most, not always, pushed out into germ tubes, when the nutrient solutions were exhausted. The sole difference, a negative one, however, between the newly discovered sprout forms of the various smut fungi and the fungus forms previously passing current as "sprout fungi" par excellence, which forms we encounter so very frequently in our nutrient solutions, and designate briefly as "mold (Kahm) fungi," or "yeast fungi," could be expressed only as follows: We now know the yeast or conidia-sprouts of the smut fungi not simply by their endlessly continued sprouting in nutrient solutions; we know further through the first beginnings of the culture, the sowed smut spores, that they represent nothing but special stages of development of the various smut fungi from which they were evolved; so far we do not know this of the other sprout fungi, because they have not yet been investigated from the right points of departure. From this it follows, further, that we do not judge correctly when we hold the so-called sprout fungi for independent fungi, as has been done hitherto, upon the fact alone of their endless sprouting in nutrient solutions. From the definite form of their individual members and the definite places of sprouting these must rather pass for nothing else than simple conidia sprouts of other fungi, consequently for stages in the development of higher fungous forms, which when sprouting in nutrient solutions behave like independent fungi, in just the same way as do the sprout-conidia of the smut fungi. *Artificial culture of the different smut fungi in nutrient solutions brought along then in its train as a side issue the obvious solu-*

tion of another still open question, the sprout-fungus or yeast question. It could only be considered as a simple matter of time when, through the spore culture of the remaining higher fungi, further and supplementary proof would be brought as to which forms among these fungi include in their course of development the still remaining sprout fungi which do not belong to the various smut fungi. The investigations in this direction have meanwhile, it may be mentioned in passing, already led to the most far-reaching results in the most diverse Ascomycetes and Basidiomycetes.

Aside now from the forms of smut fungi which, like *Tilletia*, produce large mycelia with conidia in nutrient solutions, and aside further from the forms which, like *Ustilago carbo*, *U. cruenta*, and *U. maydis*, produce conidia in endless sprouting in yeast form, there are still *other forms which produce conidia on the conidiophores of the germinating smut spores (the promycelia), which do not sprout directly, but always first grow out again into new promycelia until the conidia sprouting begins anew on these.* Here belong, for example, *Ustilago longissima* on *Poa aquatica*, and *U. grandis* on *Phragmites communis*, with many-celled promycelia, and *U. bromivora* on *Bromus secalinus*, with typical two-celled promycelia.

Finally, forms were also discovered, as for example *Ustilago Crameri* on *Setaria*, *U. hypodytes* on *Elymus arenarius*, etc., the *smut spores of which, germinating in nutrient solutions, produce no conidia, but only sterile germ tubes, that grow into richly-branched mycelia, which in turn also remain free from conidia.* Here afterward the single threads pushed far out, stolon-like, and abjointing, constituted, in place of the absent conidia, the richly increased mass of germs present in the nutrient solutions.

In short, these are the most essential results which the cultivation of the spores of the various smut fungi in artificial substrata, in nutrient solutions (therefore outside of the host plants, where they are found in nature) had given four years ago. The number of forms the cultivation of which was tried in nutrient solutions then amounted to more than twenty. As supplementary, I have extended the cultivation to an additional twenty forms, some of which brought to light similar peculiarities as in the first series, *e. g.*, in the genera *Schizonella* and *Tolyposporium*, which produce sprout-conidia; while others yielded new and supplementary facts, the special communication of which however, * as well

* Only incidentally I will state for example that the genus *Neovossia* and species of *Urocystis* behaved the same as *Tilletia*. Of the recently investigated forms of the old genus *Ustilago*, which in its present extent is wholly untenable, a number behaved the same as *Ustilago carbo*, and produced sprout-conidia of various shapes; others, *e. g.*, *U. caricis*, *U. subinclusa*, and *U. echinata*, germinated in a specific manner with the production of little conidiophores bearing air conidia similar to *Peronospora*. *Ustilago Vaillantii* agreed with the type of *U. longissima*; *U. hordei*, a recently distinguished form on *Hordeaceæ*, produced large, sterile, *e. g.*, conidia-free, mycelia, like *U. Crameri*, etc.

as the conclusion I have reached as to the morphological value of smut spores and as to the natural position of the smut fungi in the system of fungi, will be omitted here because they possess a strictly botanical scientific value, but do not directly contribute to the understanding of smut diseases, and their propagation, subjects now specially in question.

From the ease and luxuriance with which these cultivated parasites, vegetated and fructified in the nutrient solutions, with most abundant increase of their germ cells in just the same way as any other fungous forms occurring in nature as saprophytes, the conclusion followed almost of itself that smut fungi can also vegetate in nature on dead substrata like all other saprophytes, and that, although invisible to the naked eye, they here run through just the same forms as were found in the nutrient solutions and have just been described. This conclusion found still further support in the fact that I had used as nutrient solutions and nutrient substrata for the smut fungi the entire series of media, the composition and compounding of which I had given in detail in my *Culture Methods for the Investigation of Fungi* and had ascertained as suitable for the cultivation of saprophytic fungi, especially extracts from the fresh dung of our domestic animals, in which the development of the smut fungi took place with the same ease as all other saprophytes which were cultivated therein. The wide-spread occurrence of the most various yeast conidia in the dung of herbivorous animals, conidia which are in no way different from those of the investigated smut fungi, was in accord with this conclusion, and further experiments by sowing smut spores in fresh dung not too wet proved directly the increase of the germs in the fresh dung substances of the earth. Finally, the long known and uniform statements of husbandmen that their grain was especially subject to smut when they had impregnated the field with fresh dung found its equally simple and natural explanation in the now actually established increase of smut germs in the fresh dung.

Instead of smut spores almost incapable of germination in water, *e. g.*, corn smut; instead of only scattering and rudimentary spore germinations in mere water, *e. g.*, oat smut, from the activity of which, according to the knowledge of the time, the occurrence of smut and the spread of smut diseases could only be derived, there was now brought to light through the new discoveries and their consequences, an entirely new and rich vegetative condition of smut fungi. This made the question not one of exclusive parasites and their exclusive development on the host plants, but revealed, as it were, a most productive *center of infection, outside of the host plants*, for the propagation of smut diseases; a center of infection in which are operative not the few weak germs of water germination but an abundance of conidia capable of vigorous germination—conidia which can grow out easily into long germ-tubes and reach and attack the host plants.

However extremely probable or wholly self-evident it may now seem to have been from the beginning that germs of smut fungi, developed

in nutrient substrata of all sorts, might actually produce the smut diseases in the host plants; however convincing the experience of husbandmen on the relations of fresh dung to the appearance of smut diseases in grain,—the described results of artificial cultivation being also consonant—these alone do not amount to conclusive proof, but remain probabilities with which we can not be satisfied. *The new investigations of smut fungi, which began with the cultivation of the parasites outside of the host plants and which with the results here attained are half exhausted, will not be conclusive and exhaustive for the ætiology of smut diseases until the supplementary half is appended, until through various and rationally conducted infection experiments it is actually shown in what way and under what circumstances the richly multiplied germs living saprophytically outside of the host plants attack the latter and produce the smut diseases, how and in what places the germs penetrate into the host plants, and how within these, widely diverging from the transformations outside of the host plants, they are changed into smut spores.*

And now, for these infection experiments, the easy maintenance of smut fungi in any sort of nutrient solution and the subsequent endless increase of their germs, offered an inexhaustable source for the production, at will, of an infective material no less fresh and vigorous than capable of attack—a material, immediately and easily available in all possible variations, never before used, and admirably adapted for the artificial production of smut diseases in the host plants.

(*To be continued.*)

ON THE EFFECTS OF CERTAIN FUNGICIDES UPON THE VITALITY OF SEEDS.

A. A. CROZIER.

The influence of various chemicals upon the germination of seeds is but little understood. Many which have a fertilizing effect when applied in small amounts to the growing plant are injurious when a strong solution is applied to the seed. There is evidence, on the other hand, that many substances when applied to the seed will hasten germination and increase the vigor of the young plants. An account of some of these is given by Prof. L. H. Bailey, in Bulletin 31 of the Michigan Agricultural College.

The following experiments were made with blue vitriol and copperas at the Iowa Experiment Station in 1889:

First, a rough test was made with a strong solution of blue vitriol, a teaspoonful in half a saucer of water. Corn was soaked in this twenty-four hours, and another lot soaked in pure water the same length of time, and both lots planted in soil in the greenhouse May 11. Examination was made daily with the following results, the figures showing

the number of plants which had appeared above the soil on the given dates, 100 seeds of each having been planted:

I.—*Blue vitriol upon corn.*

Date.	Twenty-four hours.		Date.	Twenty-four hours.	
	Water.	Blue vitriol.		Water.	Blue vitriol.
May 16	57	5	May 24	98	85
17	96	45	25	98	86
18	97	52	26	98	86
19	97	56	27	98	86
20	98	71	28	98	87
21	98	77	29	98	87
22	98	79	30	99	87
23	98	80	31	99	89

The above table shows that the treatment with blue vitriol prevented the germination of some of the seeds and greatly retarded the germination of most of the others. Many of the plants from the seeds treated with the blue vitriol came up feeble, with leaves which appeared as though scorched. On June 7, a part of these plants had become healthy, but they were as a whole much smaller than those from the seed soaked in water only. The set treated with vitriol contained twenty-eight plants, which were notably weak, and the other set but three weak plants.

The next trial was with a solution of 10 gallons of water containing 5 pounds of blue vitriol (see Circular 5, of Sect. Veg. Path. U. S. Dept. Ag., p. 5). The seeds were placed in the solutions on May 28, and allowed to remain for three different periods before planting. Examinations were made at the dates indicated, the figures showing the number of plants which had appeared above the soil from time to time. One hundred seeds were planted in each case as before.

II.—*Blue vitriol upon corn.*

Date.	Ten minutes.		Five hours.		Twenty-four hours.	
	Water.	Blue vitriol.	Water.	Blue vitriol.	Water.	Blue vitriol.
June 5	10	5	0	0	2	0
6	57	41	20	7	40	20
7	81	63	75	41	77	60
8	91	85	91	72	87	75
9	95	87	93	85	89	79
10	95	89	93	87	91	88
11	95	92	93	91	93	93

Here a general retarding effect of the blue vitriol is visible, even when the application was made for the shortest time. The exceptions which appear are not sufficient to disturb the general result. There was also an enfeebling effect upon the young plants. On June 8 there were in the lot from seed which were soaked in water for ten minutes 6 feeble plants, and in that treated with vitriol for the same time, 23; in the lot treated with water five hours, 12; in that with vitriol, 19; in the lot treated with water twenty-four hours, 4; in that with vitriol, 22; making a total from 300 seeds soaked in water of 22 feeble plants, and from the same number soaked in blue vitriol, of 64.

The next table shows the results of the same solution upon wheat, the dates and conditions being the same as above.

III.—*Blue vitriol upon wheat.*

Date.	Ten minutes.		Five hours.		Twenty-four hours.	
	Water.	Blue vitriol.	Water.	Blue vitriol.	Water.	Blue vitriol.
June 5	77	46	60	23	45	2
6	81	55	77	40	82	10
7	81	58	78	42	86	16
8	82	62	82	43	91	23
9	83	74	85	45	92	29
10	83	79	85	45	92	34
11	85	80	85	48	93	37

It will be noticed from the above table that the wheat germinated much more quickly than the corn, and that the injurious effect of the blue vitriol was somewhat greater.

A more severe test was made with the same solution of blue vitriol (5 pounds to 10 gallons) upon the same sample of wheat by allowing about a pint of the seed to remain in the solution for thirty-nine hours, and the same amount in water for an equal length of time. At the end of that time the water was turned off, a part of the seeds of each lot kept damp by blotting paper, and the remainder planted. Nearly all the seeds which had been in water grew well, but none of those which had been in the solution of blue vitriol.

The next trial was of a solution of copperas or green vitriol upon corn. Copperas is used as a fertilizer, as a fungicide, and as an insecticide. Griffeth in his treatise on manures (London, 1889) after treating extensively of its use as a fertilizer, mentions its value as a fungicide, and states (page 302) that all fungous diseases of wheat may be destroyed by a top dressing of 50 pounds of copperas per acre, or by soaking the seed in a 1 per cent. solution.

In Bulletin 5 of the Iowa experiment station, on page 164, reference is made to the use of copperas as a remedy for cut-worms, the amount recommended being a little over 1 pound for a bushel of seed, with water sufficient to cover the grain.

This strength was taken for the trial, comparison being made with a much stronger solution, and also with pure water. The trial was made in duplicate, one set in the green-house, the other in the open ground, the other conditions being the same. The seed was soaked in each case twenty-four hours, and planted May 17, 100 kernels in a place as in the other tests. The examination was made daily, and, as in the other cases, as nearly as practicable at the same hour, usually at 6 a. m. The record begins on the day upon which the first plants appeared above ground.

IV.—*Copperas upon corn.*

Date.	(a) In the green-house.			(b) In the open ground.		
	Water.	Copperas, 1 pound per bushel.	Copperas very strong.	Water.	Copperas, 1 pound per bushel.	Copperas very strong.
May 24	51	35	16	12	1	1
May 25	84	70	45	45	32	20
May 26	91	79	68	68	65	59
May 27	94	86	72	80	76	73
May 28	94	87	80	82	80	74
May 29	94	88	85	83	81	79
May 30	94	93	86	84	86	79

A comparison of Tables IV with Tables I and II is sufficient to show that green vitriol (copperas) has nearly as injurious an effect upon the seed as blue vitriol. There was no scorching of the leaves noticeable, however, resulting from treatment with copperas, even with the strongest solution.

TREATMENT OF BLACK-ROT, BROWN-ROT, DOWNY MILDEW, POWDERY MILDEW, AND ANTHRACNOSE OF THE GRAPE; PEAR SCAB AND LEAF-BLIGHT, AND APPLE POWDERY MILDEW.

By B. T. Galloway.

BLACK-ROT.*

The experiments of the past two years have demonstrated beyond question the possibility of cheaply and effectively preventing this disease. Many things, however, in connection with its treatment remain to be discovered, so that rules now laid down will probably have to be modified, as future work gives us a better insight into the nature of the disease and the effects of different fungicides upon it. In the light of our present knowledge we would suggest the following lines of treatment, from which we will leave our readers to make their own selec-

***Læstadia Bidwellii,* (Sacc.) V. R.

tions, since there is little choice, so far as the actual value of the remedies are concerned.

I. After pruning, collect and burn all the trimmings, also as many of the old berries and leaves as possible; the object of this is to destroy the fungous spores which are known to pass the winter in these parts. This accomplished, watch the vines carefully, and as the leaves begin to unfold apply the Bordeaux mixture, formula *b*, taking care to have it reach all parts of the vine above ground. About the time the flowers are opening make a second application of the same formula, this time giving particular attention to the green parts. A third spraying should be made twelve or fifteen days later, a fourth after the lapse of a similar period, and so on until the berries begin to color. A line of treatment, such as the foregoing, will necessitate six or seven sprayings, and the total cost of the same will probably range from $5.50 to $7 per acre, or practically 1 cent per vine.

II. Treat the vines exactly as in I, excepting the first application, which may be omitted entirely, the first spraying being the one made when the flowers are opening. It is not out of place to say here that in no case should the first spraying be postponed later than the last-mentioned period. This treatment will, of course, cost less than I, but whether it will pay to omit the first spraying is one of the questions not yet determined.

III. Treat the same as I, but after the third application abandon the Bordeaux mixture and substitute the ammoniacal solution of copper carbonate. It is very likely that this treatment will prove as effectual as I; at the same time the cost will be less, and the troublesome spotting of the fruit, which always results from the use of the Bordeaux mixture, will be avoided.

IV. Substitute the ammoniacal copper carbonate for the Bordeaux mixture, making the first spraying when the flowers are opening and the others the same as in I. Former experiments have led us to believe that in ordinary seasons this solution will prove as effective as the Bordeaux mixture, and its advantages over the latter are (*a*) ease of preparation and application, (*b*) cheapness, and (*c*) its property of not spotting the fruit.

Those desiring to make further trials should test the effect of spraying the vines in spring, before vegetation starts, with the simple solution of copper sulphate or Bordeaux mixture, formula *a*. It is claimed by some that this early treatment has resulted in much good, but on the other hand there are those who have derived no benefit whatever from it. The question is one to be settled by careful experiments. For further remarks on this subject, see Notes on Fungicides.

BROWN-ROT AND DOWNY MILDEW.*

These diseases, which are caused by the same fungus, occur in nearly all sections where black-rot prevails, and experience has shown that one treatment will answer for all. In the great grape-growing regions

**Peronospora viticola,* DBy.

of northern Ohio and central and eastern New York, where the downy mildew is the principal enemy, the ammoniacal copper carbonate solution will prove an effectual preventive. It should be applied thoroughly to all the green parts of the vine, taking care to make the first application *before any signs of mildew have appeared*—say, soon after the berries are well set. The importance of early treatment can not be too strongly urged. In all cases it must be remembered that these treatments are *preventive*, and being such, it is sheer folly to wait until the enemy appears before beginning the fight.

POWDERY MILDEW.*

It is only in certain parts of the South and along the Pacific coast that this fungus causes any serious damage. In California it has long been the bane of the grape-grower, and this is strange, considering the fact that it is one of the easiest diseases to combat. It succumbs readily to sulphur either in the form of the flowers of sulphur or solutions of the sulphide.

In applying the sulphur, bellows should be used, and the first applications should be made ten or twelve days before the flowers open, the second when in full bloom, and a third three weeks or a month later if the disease seems to be on the increase. The best results are obtained when the applications are made with the thermometer ranging from 80 to 100° F. In this temperature fumes are given off, which quickly destroy the fungus.

We have obtained excellent results in treating this disease with a solution made by dissolving half an ounce of potassium sulphide to the gallon of water. This preparation is cheap and can be quickly and effectually applied with any of the well known spraying pumps. The greatest care should be exercised in making the second spraying, which, by the way, should be at the same time as that mentioned for the flowers of sulphur, in order to protect the blossoms from the fungus.

ANTHRACNOSE.†

This is one of the most difficult of all the grape diseases to combat; in fact we must admit that so far no reliable means of preventing it are known. We can only suggest, therefore, such lines of treatment as have given the best results, hoping that future investigations may throw more light on the subject.

In early spring, before the buds swell, remove, so far as possible, the wood showing the scars made by the fungus, and then treat the vines with a saturated solution (20 per cent. at 20° C.) of iron sulphate. The French apply this by means of mops made of rags, attached to short handles. This is rather slow and awkward work, and we prefer to do it with a spraying machine. As soon as vegetation starts watch the vines carefully, and at the first appearance of the disease apply

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* *Uncinula ampelopsidis*, Pk. † *Sphaceloma ampelinum*, DBy.

with a sulphuring bellows a powder made of equal parts of flowers of sulphur and slaked lime. If this does not check the malady, try the sulphur alone.

PEAR SCAB* AND LEAF-BLIGHT.†

Excepting the well known fire blight these diseases are the worst enemies of the pear. They are especially prevalent in New Jersey, Delaware, and adjoining States, frequently causing the loss of entire crops of fruit and thousands of seedlings. The seedlings are especially subject to leaf-blight, but are hardly ever, so far as we know, seriously injured by scab. As the two diseases, however, are usually associated on large trees, and as we have used the Bordeaux mixture successfully on the seedlings, we would suggest that it be adopted for all and applied as follows:

Seedlings.—Make five applications, the first when the leaves are one-quarter grown, others at intervals of ten days until the trees are budded.

Large trees.—Spray five times; first when the fruit is the size of peas, and thereafter at intervals of twelve or fifteen days.

For applying the mixture to trees less than 12 feet high, and especially to seedlings in the nursery, the knapsack pumps provided with the improved Vermorel lance and nozzle will answer.

Where the trees are large and in considerable numbers it will pay to get a strong force-pump, mount it on a barrel, and place the whole in a wagon or cart to be moved about at pleasure. In all cases, however, it will be necessary to use the Vermorel nozzle, as it is the only nozzle of value that will not clog; it can readily be attached to almost any force-pump, and will be found to be a very effective piece of machinery.

The total cost of a course of treatment such as is outlined above, including labor in preparing and applying the remedies, will be for nursery stock about $3 per 1,000 trees. For large bearing trees the cost will run from 6 to 12 cents per tree. In case the Bordeaux mixture shows on the fruit at the time of harvesting it can easily be removed by washing in water.

In addition to the foregoing it would be well to rake the old leaves and fruit together in the fall and burn them, as in this way thousands of the reproductive bodies will be destroyed.

In regions where the scab alone prevails the treatment recommended for apple scab might be tested.

POWDERY MILDEW OF THE APPLE.‡

Powdery mildew is especially destructive to seedlings in the nursery, attacking them soon after the leaves unfold and continuing throughout the growing season, making it impossible to bud them with any degree of success.

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* *Fusicladium dendriticum*, Fckl.

† *Entomosporium maculatum*, Lév.

‡ *Podosphæra oxyacanthæ* (DC.), DBy.

When the leaves are about one-third grown begin the treatment by spraying with the ammoniacal solution. In twelve days make a second application of this solution and continue at similar intervals until six or seven sprayings have been made. The applications are best made with the knapsack form of sprayer provided with the Eddy chamber nozzle. The spray of the Vermorel nozzle is too large for this work, but the Eddy chamber can be easily attached to the lance of the former at a cost of 75 cents.

The total cost of such a treatment as outlined abo ve need not exceed 10 cents per 1,000 trees.

WHAT TO DO FOR PEACH YELLOWS.

By Erwin F. Smith.

A series of experiments with fertilizers was begun in 1889, and will be continued until complete and definite results are reached. These experiments are in twelve orchards in different localities and on a variety of soils, embracing a total of about 40 acres, with as many more for comparison. The results last year were not of such a nature as to warrant any affirmative conclusion or any general recommendation.

For the present, at least, I can only indorse the Michigan practice, which is to dig out and destroy every affected tree as soon as it is discovered.

In localities where this method has been practiced with some uniformity they still grow peaches successfully.

In the vicinity of Benton Harbor, Mich., where all the orchards were ruined between the years 1870 and 1880, there are now many fine young orchards, and the yellows has almost disappeared. In the summer of 1889, in company with Mr. Rufus H. Brunson, a former yellows commissioner, I visited many small orchards in different parts of the townships of Benton and St. Joseph, the former chief seat of the disease, and examined nearly 30,000 trees, finding only about fifty cases, nearly one-half of which were in one orchard. More than four-fifths of these trees were less than six years old. Many of the older ones, and most of those which I examined, were in fruit, and the earliest varieties were just coming into market, July 24. With a few exceptions, the only *extensive* orchards were young trees not yet in bearing, the earlier plantings having been numerous, but in a small and tentative way, no single individual caring to risk many thousand trees. Now, however, large orchards are being set. Whether the present immunity will continue is a matter of great interest. If there is any real basis for the belief that the disease may be imported, it certainly will not, for many of the younger trees were procured from infected districts in the East. All fear of the disease seems to have died out, and with it most of the former vigilance.

At South Haven, Mich., where the "rooting out" process was first practiced extensively, and where it is yet in full vigor, they have grown peaches continuously from the start (1852), and there are many old orchards, some of which have stood for twenty-five years. In that locality I examined many representative orchards, and found only a very few cases of yellows. Sometimes, as at St. Joseph, it was a day's work to find a single case. Most orchards of any size do, however, lose some trees each year, their places being filled by trees from the nursery. The South Haven growers, many of whom I have met, no longer fear the disease. They are unanimous in the opinion that the only proper thing is to dig out and burn. This plan they have followed very generally for the past ten years, during which time the disease has not prevailed seriously. Previous to that date many orchards were ruined, the disease having appeared first in 1869.

Until we have a full knowledge of the ætiology of this disease, no better plan can be suggested. Affected trees are always worthless, and the sooner they are converted into stove-wood the sooner new, healthy trees can be grown in their places. *Dig out, then, and burn, and do it promptly.*

TREATMENT OF MILDEWS UPON PLANTS UNDER GLASS.

BY S. T. MAYNARD.

In Bulletin No. 4, Massachusetts Experiment Station, April, 1889, experiments were reported upon the causes and remedies for mildews upon plants under glass. Below we give a brief summary of the results.

ROSE MILDEW.*

Long experience in growing the rose has led many to believe that the rose mildew is brought on by various conditions that weaken the vigor of the leaf, such as want of an abundance of plant food in a proper condition, unhealthy condition of the soil, often resulting from improper drainage, irregular or overwatering, or too sudden changes of temperature, especially after the plants have been forced at a high temperature. The successful rose grower therefore, is one who, by constant care and good judgment, always provides against any or all of the above causes.

REMEDY.

A sure and safe remedy, *with proper precautions*, was found in *evaporated sulphur.* In the use of this remedy a small kerosene stove with a thin iron kettle was used, and the sulphur kept boiling two or three hours thrice each week when the house was closed.

**Sphærotheca pannosa*, (Wallr.) Lév.

Precaution.—The only precaution needed is that the apparatus be placed so that there shall be no danger of its getting upset, and that only heat enough be applied to *boil* the sulphur, for, if by any accident the sulphur should catch on fire, it would destroy all the plants in the house very quickly.

Suggestion.—It has been suggested that if the pipes are painted with linseed-oil and sulphur two or three times each year, similar good results would follow. It has long been the practice to paint greenhouse pipes with a mixture of lime and sulphur, but the results have not always been satisfactory, and the above suggestion may be open to the same objection, although we know of no carefully recorded experiments in the use of linseed-oil and sulphur paint.

LETTUCE MILDEW.*

When grown at a temperature above 40° F. at night, 55° F. in cloudy, and 70° F. in sunny days, lettuce under glass is often rendered unprofitable by the attack of this disease which causes the lower leaves to decay, and often the whole plant to die quickly. Other conditions may in a measure aid in bringing on the disease; for instance, anything that may cause a weak leaf-action of the plant, too much water in the soil, and too much moisture in the house, especially during the night.

REMEDY.

Evaporated sulphur proved beneficial, but not wholly preventive, in fact, only preventive conditions were found satisfactory. These conditions are:

1. A lower temperature at night than during the day, *i. e.*, ranging from 35° F. to 45° F. at night to 50° F. to 70° F. during the day. In sunny weather the temperature may run 10° to 15° higher than on cloudy days.
2. Perfect drainage of the soil.
3. A house naturally dry, light, and airy.
4. An abundance of plant-food in a light porous soil.

Should the plants not start into a vigorous growth soon after transplanting, the application of fine ground bone, one-half pound to a square yard, and 2 ounces of nitrate of soda to the same space, will give remarkable results.

Suggestion.—While it is possible by close and constant attention to provide conditions for the successful growth of both the rose and lettuce under glass, such care and attention adds very materially to the cost of the products, and some means should be devised to destroy the germs

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* *Peronospora gangliformis*, Berk.

of these diseases. This may possibly be found in fungicides used in the houses, before the plants are started or by their application to the soil and growing crops while in a young state.

AMHERST AGRICULTURAL COLLEGE, AMHERST, MASS.

TREATMENT OF CRANBERRY SCALD AND CRANBERRY GALL-FUNGUS.

BY BYRON D. HALSTED.

It has been determined by a thorough canvass that a large fraction of the cranberry crop is destroyed by the scald, sometimes called "rot." The loss sometimes reaches as high as 65 per cent., and in many places it has rendered the growing of cranberries a profitless industry.

A fungus is closely associated with this scald, and in no case has a soft berry been examined microscopically without the same fungus being present. The leaves, vines, and roots also of the plants bearing scalded berries, abound in the same fungus. In general structure, habits, and behavior, the fungus of the cranberry scald is closely related to the one causing the black-rot of the grape. As yet no fungicides have been tested upon the scald, but from its relationship to the black-rot of the grape it is only reasonable to infer that the same treatment might be efficacious. In view of the fact that the cranberry has small smooth thick leaves it is possible that the mixtures employed for the grape could be used with greater strength upon the former. However, a beginning can be made with the ammoniacal copper carbonate solution, directions for the preparation of which will be found elsewhere in this JOURNAL. The amount of this solution to be applied per acre can not be stated because it will vary with the rankness of the vines. Apply for the first time as soon as the spring flooding is past, and again just before the blossoms unfold. The third application should be in midsummer, followed by two others at intervals of two weeks. This makes five sprayings in all. The instruments to be used will depend much upon circumstances. If the owner applies Paris green or London purple for the insect enemies of the cranberry, namely, the tip worm, vine worm, etc., then the remedy for the scald can be applied with the same pump.

There is much to be done in improving the *sanitary* conditions, if that term may be used, of the bogs. It is important to have perfect control of the water supply, and during the growing season, while keeping the bog moist enough for the plants, have the ditches deep and free-flowing that stagnant water can be kept from the roots of the plants. Doubtless much depends upon having the soil of the bog in the best condition for the healthy growth of the plants. Where the peat is sour and soaked with standing water the best conditions obtain for the scald. It may be that proper drainage, water control, and

sanding will bring the necessary conditions for healthy plants, and the old plants may outgrow the trouble with the aid, in the meantime, of the remedy proposed. The best thing to do will be to try and see, upon a small area, provided the practical pecuniary test of possible profit prompts the owner. Some bogs are so poorly adapted for this peculiar industry that it will not pay to spend money upon them, others, nevertheless, merit much more attention than they receive.

THE GALL-FUNGUS.

This appears to be confined to a single bog in New Jersey, but in that one it is disastrous. Several closely related shore plants as azalea, sheep laurel, lambkill, white alder, leather leaf, huckleberry, and tea berry or winter green, are attacked by the same fungus (*Synchytrium Vaccinii*, Thomas). The disease is spread by the water in the spring floods and does not pass readily through the air. There is some danger, however, of the pest spreading to other bogs and therefore if this bog was destroyed by fire, together with the infested shore plants there might be hope for a speedy end to the trouble. The matter is so local that it does not merit further treatment here.

The two diseases of the cranberry herein briefly treated are considered at length, with several engravings, in Bulletin 64 of the New Jersey Experiment Station.

RUTGERS COLLEGE, NEW BRUNSWICK, N. J.

TREATMENT OF APPLE SCAB.

BY E. S. GOFF.

Recent experiments indicate that apple scab (*Fusicladium dendriticum*, Fckl.) may be almost entirely prevented by the application of certain liquid preparations, in the form of a spray, that, while harmless to the foliage and fruit of the tree, are destructive to the fungus which causes the disease. Various substances have been found to be more or less beneficial, but at the present state of our knowledge, a solution of copper carbonate in ammonia largely diluted with water is to be most strongly recommended. Experiments conducted, the past season, in the orchard of Mr. A. L. Hatch, of Ithaca, Wis., with this preparation proved so far satisfactory that Mr. Hatch has decided to apply the treatment to his entire orchard of about 25 acres the coming season, as a means of increasing the income from his apple trees.

DIRECTIONS FOR PREPARING AND APPLYING THIS FUNGICIDE.

The copper carbonate and the ammonia may be procured through almost any retail druggist. As the former is not always kept in stock it would be well to order it some days before it is desired for use. The

copper carbonate should be of the "precipitated" form, and is worth at retail about 65 cents per pound. The ammonia should be of a strength of 22° Baumé, and should be procured in a glass or earthen vessel and kept tightly corked, preferably with a rubber cork.

Four ounces of the copper carbonate and 1 gallon of ammonia will be sufficient to give about fifty large or seventy-five medium-sized trees one thorough spraying. As four or five treatments will be needed for a thorough application of the remedy the amount of the materials required for any given orchard may be readily computed.

The best formula that can be given in the present state of our knowledge is to dissolve one ounce of the copper carbonate in one quart of ammonia, and dilute this, when ready to commence the application, with 25 gallons of water.

WHEN TO MAKE THE APPLICATIONS.

In the experiments made the past season in Mr. Hatch's orchard the first application was made after the petals of the flowers had fallen, and when the young apples were slightly larger than peas. But it is the opinion of Mr. Hatch and myself that one spraying before the flowers had opened would have proved beneficial. I would recommend, therefore, one treatment just before the flowers open, a second after the petals have entirely fallen, and others at intervals of two or three weeks until midsummer, or after, if the latter part of summer should be wet.

APPARATUS FOR SPRAYING.

For applying the liquid to the trees, a force-pump, to which is attached a few feet of hose, fitted at the end with a spraying nozzle, will be needed. Excellent pumps are now made by the larger manufacturers expressly for spraying purposes, fitted with all necessary attachments, and costing $10 and upwards. Smaller pumps, which would answer fairly well for a few trees, may be had at from $2 to $10 each.

The same pump which is used for treating the trees for the apple scab may of course be used for applying poisons for the codling moth and other insects. Unfortunately it will not be prudent to add the copper carbonate solution to the same water that is used in applying Paris green or London purple, as the ammonia renders the arsenic more or less soluble and thus the latter would be liable to injure the foliage. But if applied a few hours in advance of the water containing the arsenites, no harm can result from this source.

SUGGESTIONS FOR FURTHER EXPERIMENTS.

The time at which the applications should commence, the number that should be made, and the amount of copper carbonate to be used to accomplish the greatest benefit at the least cost, remain to be settled by experiment.

The most practical remedy for the apple scab must be one that may be applied in the same water with Paris green or London purple without thereby endangering the foliage. It is the opinion of our station chemist, Dr. Babcock, that not only the ammoniacal copper carbonate, but the sodium hyposulphite and the sulphides of lime and potash, all tend to render the arsenic of Paris green and London purple soluble, and hence can not be wisely used in connection with these poisons. The copper carbonate, however, which in the ammoniacal solution is the beneficial agent in preventing the apple scab, does not have this effect when used without the ammonia. The question therefore arises, is the ammonia solvent necessary?

I have recently made some tests with a sample of commercial precipitated copper carbonate, and find that its state of division is such that it remains suspended in water rather better than Paris green, and so may be applied by any apparatus that successfully distributes the latter. It apparently adheres to the foliage nearly or quite as well, when applied in simple suspension, as in the diluted ammoniacal solution.

I recommend, therefore, that those who spray their apple trees for the prevention of injury from the codling moth, make the experiment in a portion of the orchard of adding the precipitated copper carbonate to the water, at the rate of an ounce to twenty-five gallons. No harm to the foliage can result from this measure, while we have every reason to expect that much benefit will accrue in the prevention of the apple scab.

UNIVERSITY OF WISCONSIN, MADISON, WIS.

THE COPPER SALTS AS FUNGICIDES.

BY F. D. CHESTER.

In order to make an intelligent comparison between the several well known fungicides containing copper, it is important to understand what salts of copper occur in each and in what relative proportions. This in turn involves some inquiry into the chemical reactions which take place in their preparation and during their stay upon the vine.

For much valuable assistance in the preparation of these notes I am indebted to Prof. C. L. Penny, the Chemist of this Station.

THE BORDEAUX MIXTURE.

Formula.—Copper sulphate, 6 pounds; lime, 6 pounds; water, 22 gallons. In the addition of milk of lime to a solution of copper sulphate, the lime in solution precipitates the copper as cupric hydroxide, forming at the same time a slightly soluuble sulphate of lime. These two salts, together with an excess of lime, remain in suspension in the Bordeaux mixture.

The reaction is simple:

$$CuSO_4, 5H_2O + CaO,H_2O = Cu\,(OH)_2 + CaSO_4 + 5H_2O.$$

From this formula a simple calculation shows that to precipitate the 6 pounds of copper sulphate, there would be required 1.34 pounds of lime (CaO), which would in turn produce 2.34 pounds of cupric hydroxide.

The weight of lime to be used should be considerably increased above this amount, owing to its impure character as ordinarily purchased, but it is likely that 3 or 4 pounds of commercial lime will suffice to satisfy this reaction.

The 22 gallons of water is capable of dissolving approximately .235 pounds of lime, an amount sufficient to precipitate practically 1 pound of the copper sulphate. But since this quantity of lime is immediately thrown down as a nearly insoluble sulphate, the water is free to dissolve another portion of lime, which in turn precipitates another portion of the copper, until all of the copper is thrown down. It is found that this complete precipitation of the copper takes place quickly, or by the time the matter in suspension has fully settled, leaving a clear supernatant liquid, which does not react for copper; hence a long standing of the Bordeaux mixture before use is hardly necessary.

In drying upon the plant the cupric hydroxide in the Bordeaux mixture undergoes no change, hence it is probably this salt of copper which is the active principle.

EAU CELESTE.

Formula.—Copper sulphate, 1 pound; strong ammonia, $1\frac{1}{2}$ pints; water, 22 gallons.

In the addition of ammonia water to a solution of normal copper sulphate, the copper is precipitated as a basic sulphate, forming at the same time ammonic sulphate, which remains in solution. With an excess of ammonia, the basic copper sulphate dissolves to a blue fluid forming the ammonio-copper sulphate ($CuSO_4$, $4NH_3$, H_2O).

In drying upon the plant the ammonio-copper sulphate gradually loses its ammonia and is reconverted into the basic copper sulphate. The following are the probable reactions:

(1) $$\underbrace{3CuSO_4, 5H_2O}_{\text{Normal copper sulphate}} + 4NH_4HO = \underbrace{CuSO_4\,2Cu(OH)_2}_{\text{Basic copper sulphate.}} + 2(NH_4)_2\,SO_4 + 15H_2O$$

(2) $$CuSO_4, 2Cu(OH)_2 + 2(NH_4)_2SO_4 + \underbrace{8NH_4HO}_{\text{In excess.}} = \underbrace{3(CuSO_4, 4NH_3, H_2O)}_{\text{Ammonium copper sulphate.}} + 9H_2O$$

(3) In drying upon the vine.
$$3(CuSO_4, 4NH_3, H_2O) + H_2O = CuSO_4, 2Cu(OH)_2 + 2(NH_4)_2SO_4 + 8NH_3$$

To satisfy the reactions (1) and (2), the one pound of copper sulphate would require .439 pounds of ammonia gas (NH_3); or 1.66 pints of the

stronger water of ammonia of the U. S. Pharmacopœia (sp. gr. 0.900 at 15° C.), producing in turn .47 pounds of the basic copper sulphate.

MODIFIED EAU CELESTE.

Formula.—Sulphate of copper, 2 pounds; carbonate of soda, 2½ pounds; strong ammonia, 1½ pints; water, 22 gallons. In the addition of a solution of sodic carbonate to a solution of copper carbonate the copper is precipitated as a basic carbonate, forming at the same time a soluble sulphate of soda.

Upon the addition of ammonia the basic carbonate dissolves to a blue fluid forming the ammonio-copper carbonate ($CuCO_3, 2NH_3$), and the ammonio-cupric hydroxide. ($3Cu(OH)_2, 4NH_3, 3H_2O$.)

In drying upon the plant both of these salts gradually lose their ammonia, and are converted into the basic carbonate and into the cupric hydroxide.

The following are the probable reactions:

(1) $$12(CuSO_4, 5H^2O) + 12(Na_2CO_3, 10H_2O) = 6\underbrace{[CuCO_3, Cu(OH)_2, H_2O]}_{\text{Basic carbonate of copper.}} +$$

$$12Na_2SO_4 + 6CO_2 + 168H_2O$$

(2) $$6[CuCO_3, CuC(OH)_2] + \underbrace{20NH_4HO}_{\text{To dissolve.}} = 6\underbrace{(CuCO_3, 2NH_3)}_{\text{Ammonio-copper carbonate.}} +$$

$$2\underbrace{[3Cu(OH)_2, 4NH_3, 3H_2O]}_{\text{Ammonio-cupric hydroxide.}} + 14H_2O.$$

(3) In drying upon the plant.

$$6(CuCO_3, 2NH_3) + 6H_2O = 3\underbrace{[CuCO_3, Cu(OH)_2]}_{\text{Basic carbonate of copper.}} + 3(NH_4)_2CO_3 + 6NH_3$$

$$2[3Cu(OH)_2, 4NH_3, 3H_2O] = 6Cu(OH)_2 + 8NH_3 + 6H_2O.$$

From the above formula it is found that to satisfy the reaction, the two pounds of copper sulphate will require 2.3 pounds of crystallized carbonate of soda, which will eventually produce .44 pounds of basic carbonate of copper and .38 pounds of the cupric hydroxide, or a total of .82 pounds of the mixed salts.

AMMONIACAL COPPER CARBONATE.

Formula.—Copper carbonate, 3 ounces; strong ammonia, 1 quart; water, 22 gallons.

In the preparation of this solution, the chemistry is the same as that given under modified eau celeste and the reactions are given in formulæ (2) and (3).

Upon the same basis as before, 3 ounces of copper carbonate will yield 1.5 ounces of basic carbonate and 1.32 ounces of cupric hydroxide, or a total of 2.82 ounces. The difference between the modified eau celeste and the ammoniated copper carbonate consists in the presence of sodium sulphate in the former material, and its absence in the latter. Whether this sodium sulphate will be at all harmful to foliage is a question to be decided by experiment, and the writer would advise that this question be tested. The cost of the copper carbonate in the modified eau celeste is approximately 20 cents per pound, while the cost of the commercial carbonate, is, according to present quotations, 65 cents per pound. Furthermore it is seen from the following table that the cost of the basic salts of copper deposited upon the plant, is, in the modified eau celeste, 29 cents per pound, and in the ammoniacal copper carbonate 94 cents per pound; a difference worthy of serious consideration.

In the use of both the modified eau celeste and the ammoniacal copper carbonate there is not produced continually a basic carbonate of copper, but a mixture of the basic carbonate, and the hydroxide. Would it not therefore be well to try the pure basic carbonate either by precipitating the copper with sodium carbonate, and applying it in suspension as the hydroxide is applied in the Bordeaux mixture or by dissolving this precipitate in ammonium carbonate? By the former method, using 2 pounds of copper sulphate, and 2½ pounds of sodium carbonate, we would have an extremely cheap and perhaps effective fungicide.

The following table has been constructed that the facts contained in this paper might be presented in a condensed form.

The writer in conclusion would particularly recommend that the relative value of the hydroxide, the basic sulphate, and the basic carbonate be tested by the application of materials containing equal weights of these salts per unit of water.

Name of fungicide.	Form of salts when dry upon the plant.	Weight of foregoing salts per 22 gallons.	Weight of original copper salt to make 1 pound of salt when dry on plant.	*Cost of fungicides per 22 gallons.	Cost of 1 pound of copper salt when dry on plant.
		Pounds.	*Pounds.*	*Cents.*	
Bordeaux mixture	Cupric hydroxide, $Cu(OH)_2$	2.34	2.5	34.25	\$0.146
Eau celeste	Basic copper sulphate, $Cu\ SO_4$, $2Cu(OH)_2$.	.47	2.13	21.25	.452
Modified eau celeste	Basic copper carbonate, $Cu\ CO_3$, $Cu(OH)_2$, and Cupric hydroxide, $Cu(OH)_2$.	.82	2.44	24.37	.297
		Ounces.			
Ammoniacal copper carbonate.	Basic copper carbonate, $CuCO_3$, $Cu(OH)_2$, and Cupric hydroxide, $Cu(OH)_2$.	2.82	1.06	16.6	.942

* Wholesale cost of materials from which calculations in the last two columns of the above table were made: Copper sulphate, 5⅜ cents per pound; sal soda, 1½ cents per pound; strong ammonia (26°), 7 cents per pound; copper carbonate precipitated from copper sulphate by sal soda, 13.87 cents per pound.

DELAWARE COLLEGE, NEWARK, DEL.

NOTES ON FUNGICIDES AND A NEW SPRAYING PUMP.

By B. T. Galloway.

In connection with the papers found elsewhere in the Journal, it would seem proper to say something in regard to the preparation of fungicides, particularly those recommended for use. The manner of preparing most of these, however, has been so fully described in former publications that we deem it unnecessary to repeat the descriptions here. We will say, in passing, that the circulars—Nos. 5 and 6 of the Section of Vegetable Pathology—containing this information will be forwarded to all those desiring to consult them.

Aside from the old and well established preventives and remedies, there are several new ones which we think it would be well to call attention to in order that they may be more fully tested. The first of these is a solution of copper acetate or verdigris, which was mentioned in Volume 5, Number IV, of the Journal. It is prepared as follows:

Dissolve 3 pounds of powdered verdigris in 6 to 8 gallons of water and after standing for twenty-four hours dilute to 22 gallons. If desired the amount of verdigris may be increased to 4 pounds without injury to the plants.

This preparation being comparatively cheap and easily prepared, it would be well to test it for downy mildew and black-rot of the grape, making the applications as described for Bordeaux mixture and the other well-known preparations.

Another preparation which might be tried for downy mildew is made as follows:

Dissolve 5 pounds of alum in 3 or 4 gallons of boiling water, and then pour this solution into a half barrel or tub containing sufficient cold water to make 15 gallons. In another vessel dissolve 42 pounds of calcium chloride in 3 gallons of cold water. Finally, pour the calcium chloride solution slowly into the alum preparation, stirring constantly to effect a thorough mixing.

When the two solutions are mixed there is formed aluminium chloride, potassium sulphate, and calcium sulphate. It is claimed that the fungicidal property lies in the first, while the calcium sulphate facilitates its adhesiveness. The potassium sulphate is, as every one knows, a fertilizer and as it is washed from the leaves it enriches the soil.

In addition to what is said here the papers of Professor Goff and Professor Chester should be carefully consulted, as they contain several new and important suggestions in regard to the preparation and application of fungicides. For the benefit of those having in mind the treatment of plant diseases the coming season, we quote below the usual prices of the various chemicals used in the preparation of fungicides. The quotations are for 100-pound lots. In smaller quantities the prices will range from one fifth to one-third higher, so that money will be saved

if farmers and fruit-growers will club together in making their purchases. Such an arrangement will also save considerable in the way of transportation expenses.

	Per pound.		Per pound.
Copper carbonate	$0.60	Iron sulphate	$0.02
Copper sulphate	.08	Flowers of sulphur	.04
Potassium sulphide	.25	Alum	.03½
Aqua ammonia (22 Beaumé)	.08	Calcium chloride	.06
Sodium hyposulphite	.03	Aluminium sulphate	.05
Copper acetate	.30	Lime per barrel	2.00

NEW SPRAYING PUMP.

Ever since the work of the Section was inaugurated there has been felt the need of a cheap, serviceable, and effective apparatus for spraying grapes and all the low-growing crops. Heretofore we have had to rely mainly upon machines imported from France; in fact, with but one exception, the only pumps that have given satisfaction in our vineyard work have been purchased abroad. The average fruit-grower can not afford to send to France for a machine that will cost him, laid down in this country, all the way from $18 to $25, nor can he pay $21 for a pump made here, notwithstanding the fact that it is a most excellent machine and costs almost the selling price to manufacture it. In short, a knapsack pump, be it ever so serviceable, at $21 or even $18, is entirely beyond the reach of the average farmer, gardener, and fruit-grower. Consequently he has to rely upon inferior machines, and, as a result, his treatments are frequently unsuccessful for the simple reason that the remedies are not properly applied.

We have had the matter of providing a cheap and serviceable knapsack pump under consideration for some time, and can now positively announce that the machine will be on the market in a few weeks. The pumps will be made in two or three styles, and as there will be no patent on them we hope manufacturers throughout the country will be able to offer them at about $12, thus placing them within the reach of all.

PREVENTION OF SMUT IN OATS AND OTHER CEREALS.

By W. A. Kellerman and W. T. Swingle.

The smuts of oats and other plants are minute vegetable parasites. They appropriate for their use the nourishment which the infected plant prepared for its own development, and in this way reduce its vitality or completely destroy the part attacked. The dark-colored powdery mass popularly called the smut is merely the mature fruit of the parasite, and consists of exceedingly minute reproductive bodies

called spores. These, when subjected to proper conditions, germinate by sending out a slender tube upon which small sporidia appear.

The smut arrives at maturity in case of oats when the latter are in bloom, and the spores, blown hither and thither, find their way into the flowers. The husks soon close over the young grain, and the spores which may have been thereby imprisoned remain dormant until the seed is planted in spring. The warmth and moisture cause the spores and the oats to germinate simultaneously. The slender tubes emitted by the spores now penetrate the delicate oat plants. Thereafter the smut plant grows concealed within its host until they both approach maturity. At this time the smut spores rapidly develop in the abortive head of oats and the black mass of smut becomes conspicuous.

It is sometimes claimed that smut in the soil, or in manure applied to the soil, will infect the young oat plants. This is certainly not the usual mode of infection and it may be doubted whether it ever occurs.

If the spores inclosed in the husks of the grain can be killed without injuring the seed, the smut can be perfectly prevented in the crop. This has usually been accomplished by soaking the seed in a solution of blue vitriol (copper sulphate). This process though destroying all or nearly all the smut, also injures the seed more or less. The hot-water method of Professor Jensen has proven thoroughly effectual in preventing smut and, besides, is not in the least injurious to the seed. In fact, both our own and Jensen's experiments show yields greater than would be expected from the mere prevention of the smut. We therefore recommend this treatment, which consists simply in immersing the infected seed in scalding water (132° Fahr.) for not less than five nor more than fifteen minutes, and immediately thereafter cooling it quickly by immersing in cold water.

In order to carry out this process satisfactorily when a large amount of seed is to be treated, two large vessels must be provided. These can be large kettles hung over a fire, or large boilers on a cook-stove. One vessel is to contain heated water (about 110° to 120° Fahr.) for the purpose of warming the seed preparatory to dipping into the second vessel. This second vessel is to contain water at a temperature of 132° to 135° F. Were not the seed warmed before dipping into the vessel of scalding water the temperature of the latter would be very much reduced, perhaps below 130°, and then the treatment would not be effectual. The seed, a half a bushel or more at a time, is to be placed in a coarsely-woven basket having a lining of wire netting with meshes fine enough to prevent the egress of the grains, say, twelve to the inch. A heavy wire bushel-basket may be used, or a light iron frame made over which the wire netting may be stretched. A lid or cover must be provided for, otherwise a portion of the seed will escape upon immersion. A sack made of coarsely woven cloth might be used instead of the basket, but it is much less convenient. It is necessary that the basket admit the water freely and immediately upon its immersion,

otherwise the treatment can not be expected to be effectual. An immersion of a few moments (less than a minute) will sufficiently warm the basket of seed, provided that it be lifted out then plunged in a time or two and shaken or revolved so that the water may come in contact with the grains. Then plunge it immediately into the second vessel, and with similar motion bring every grain into immediate contact with the scalding water. The lifting and plunging should be continued at short intervals until the seed is removed. In this way every portion of the seed will be subjected to the action of the scalding water. Immediately after its removal dash cold water over it or plunge it into a vessel of cold water and then spread out to dry. Another portion can be treated similarly, and so on till all of the seed has been disinfected.

The important precaution to be taken is as follows: *Maintain* the proper temperature of the water (132° Fahr.), in no case allowing it to rise higher than 135° or to fall below 130°. This will not be difficult to do if a reliable thermometer is used and hot or cold water be dipped into the vessel as the falling or rising temperature demands. Immersion fifteen minutes will not then injure the seed, though no doubt in a less time it will be thoroughly disinfected.

The seed can be treated any length of time before sowing. If it is to be stored it would be necessary to have it first thoroughly dried. If treated immediately before using it can be sowed broadcast when dried sufficiently to prevent adhesion of the grains, but for planting with the drill it would need perhaps to be more nearly dry.

The above outline of treatment is for oats, wheat, and rye. Professor Jensen has determined that barley must be previously soaked in cold water eight hours, otherwise the smut is not prevented.

It is to be remembered that this treatment if universal in any section of country will, besides preventing smut in the crop of the season, also insure clean seed for use the following year. It has been established by actual count that the smut often destroys a very large percentage of the crop. When the smut was reported to be inconsiderable or even absent, we have determined that there may be 5 to 15 per cent. of the heads smutted. These are at harvest time usually overlooked because the smut has been blown away and the inconspicuous naked and clean stalk only remains. It might be added in this connection that it has been established recently that the smuts of barley and wheat, though much resembling that of oats, are really different species.

Finally we may mention by way of suggestion for the benefit of others that farther experimentation is now being prosecuted, or about to be undertaken, having in view the determination of numerous points in connection with the application of fungicides for the prevention of smut. Among these are the following: A comparison of the efficacy under varying conditions of the hot-water treatment with other fungicides; comparison as to increase of yield when this or any other fungicides are used; trial of the Jensen method with other plants besides oats and

wheat, as barley, rye, grasses, millet, and maize; and the determination of the most favorable form of treatment, particularly with reference to the degree of temperature required, the duration of the immersion in hot water, and the mode of cooling.

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OBSERVATIONS ON THE DEVELOPMENT OF SOME FENESTRATE SPORIDIA.

(Plates I & II.)

BY CHARLES E. FAIRMAN.

The following notes have been made on the development of the sporidia in *Fenestella amorpha*, E. & E.,* and in *Patellaria fenestrata*, C. & P.,† A few comparisons have been made with the spore development of *Camarosporium subfenestratum*, B. & C.

In *Fenestella amorpha* we find the first stage of sporidial development to be represented by the formation of a finely granular protoplasmic layer, in the interior of the ascus. Numerous spherical drops may also be seen a little later in this condensed protoplasmic layer. This layer was not seen to impinge upon the walls of the ascus at any point.

A light-colored homogeneous fluid occupied the space between this layer and the walls of the ascus. Also it was noted that the granular layer did not touch the walls of the ascus at the top or apex. At first this layer appears quite homogeneous. We have designated it the *Sporidiogenic layer* (Fig. 1, plate I).

The sporidiogenic layer is generally broader at the apex of the ascus and narrows somewhat towards the base. In *Patellaria fenestrata* the same general characteristics of this layer will be found to exist. In this species the sporidiogenic layer is at times continuous with the base of the ascus, a condition of affairs which was not made out in the case of *Fenestella* (Fig. 14, plate II).

The next feature observed in the development was the formation of larger spherical bodies in the interior of the sporidiogenic layer. These spherical bodies are the first indications of the forming sporidia (Figs. 2, 3, and 4, Plate I, and Figs. 15 and 16, Plate II). In *Fenestella amorpha* the number generally found was 8, and in *Patellaria fenestrata* 4 (although more may be occasionally seen in the latter). As mentioned above, the general outline is spherical, and they seem to be placed at nearly equal distances apart, in number corresponding to the sporidia commonly found in the ascus of the species under consideration. They are the forming or immature sporidia. Nuclei next make

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*Journn. Mycol., Vol. IV, p. 58. †28th Report N. Y. State Mus., p. 68.

their appearance in the primitive sporidia (Fig. 2, Plate I, and Fig. 15, Plate II).

In *Fenestella amorpha*, with the appearance of the nuclei in the immature sporidia, the sporidiogenic layer begins to lose its distinctness of outline and to be either absorbed or resolved.

In *Patellaria fenestrata* the sporidiogenic layer persists longer. (See Fig. 16, Plate II.) Our observations will not warrant a definite answer to the question how long it does remain. It has been suggested that it persists to the full development of the sporidia and forms a mucous coating to the sporidia (of *Patellaria*). Peck, in 28th Rep. N. Y. State Museum, page 68, says of this species: "Asci subclavate, spores four to eight *involved in mucus*, large pyriform," and gives later as one of the points of distinction between this species and *Patellaria dispersa*, Ger., that "the spores are longer in proportion to their breadth and involved in mucus." The nuclei increase in number, but this increase is variable in different species and probably in the same species. The number of separate divisions in the matured sporidia corresponds closely with the number of nuclei formed during the process of segmentation of the sporidia.

In *Fenestella amorpha* from 5 to 7 nuclei form inside the sporidia, in *Patellaria fenestrata* 7 or more, in *Camarosporium subfenestratum* spores from 4 to 7. (Fig. 19, Plate II.)

The nuclei now enlarge and fill up the sporidia. Some of them subdivide into two or more. In *Fenestella amorpha* the majority subdivide. In *Camarosporium subfenestratum*, as far as observed, the nuclei do not all subdivide. Generally a few near the middle of the spore subdivide.

Up to the commencement of this stage the sporidia of *Fenestella amorpha* are hyaline or subhyaline; but with the subdivision of the contents of the sporidia we find a decided darkening in color. In *Patellaria fenestrata*, and in *Camarosporium subfenestratum* also, the same change of color becomes noticeable. As the development of the sporidia progresses the color gradually darkens.

With the increase in size of the divisions of the sporidia and the changes in the secreted cell walls we now have in *Fenestella amorpha* very dark-colored sporidia, whose *transverse septa* correspond to the limits of the first formed nuclei, and the *longitudinal septa* to one or more of the subdivisions of the same.

In *Fenestella amorpha* the longitudinal septum is irregular; where the subdivisions number three the longitudinal septum runs between them, so that we have one on one side and two on the other, and where the subdivisions are four, two will be found on each side of the septum.

To recapitulate.

The development of fenestrate sporidia may be divided into three stages, viz:

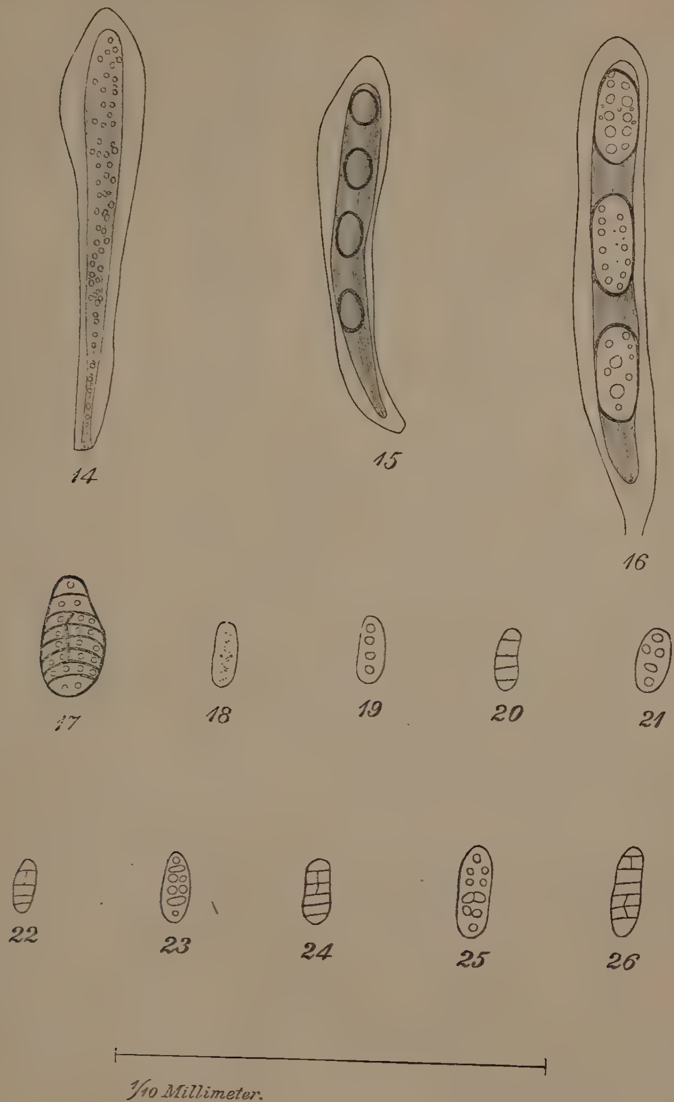
First. The formation of the sporidiogenic layer.

Second. The segmentation of the immature sporidium.

Third. The maturation.

C. E. FAIRMAN, DEL.

FAIRMAN ON DEVELOPMENT OF SPORIDIA.



C. E. FAIRMAN, DEL.

FAIRMAN ON DEVELOPMENT OF SPORIDIA.

EXPLANATION OF PLATES.

PLATE I.

FIGS. 1 to 13. Development of sporidia of *Fenestella amorpha.*
1. Formation of sporidiogenic layer.
2, 3, and 4. Primitive sporidia.
5–12. Stages in sporidial development.
13. Mature ascus and sporidia.

PLATE II.

FIGS. 14–17. Sporidial development of *Patellaria fenestrata.*
14. Formation of sporidiogenic layer.
15–16. Formation of primitive sporidia.
17. A nearly developed sporidium.
18–26 represent stages in development of spores of *Camarosporium subfenestratum.*

The scale applies to both plates.

NEW SPECIES OF FUNGI.

By J. B. ELLIS AND B. T. GALLOWAY.

ÆCIDIUM CREPIDICOLUM, *n. s.* On leaves of *Crepis acuminata*, Helena, Mont., June, 1889. Rev. F. D. Kelsey, No. 98. Amphigenous, small, clustered but not crowded, often subcircinate around a vacant space in the center, hemispheric and closed at first, soon open, peridium thin, white, margin narrowly reflexed, at length lacerate cleft nearly or quite to the base. Spores subglobose, 20–24μ, varying to ovate and elliptical, 20–30 by 15–20μ (smooth?) with a rather thick epispore. The leaf is slightly thickened in the affected spots. Clusters 2–3 milimeters in diameter, few on a leaf, or smaller (3–6 æcidia together) and then more numerous. Differs from *Æcidium crepidis*, Thüm. in having the æcidia mass deeply buried in the leaf. *Æcidium Rostruppii*, Thüm. has the æcidia larger, but possibly our plant may not be distinct from *Æcidium Barkhausiæ*, Roum.

USTILAGO (SOROSPORIUM?) BRUNKII, *n. s.* In sheaths of *Andropogon argenteus*, destroying the inflorescence. College Station, Brazos County, Tex. H. S. Jennings. Inclosed in the sheaths without any distinct membranaceous covering. Spores globose or ovate, 10–18 μ, in diameter, often apiculate, olivaceous brown under the microscope, finally subopaque. Epispore smooth, thick (3–4 μ). The spores are partially agglutinated and hence are not as loosely pulverulent or dusty as in most species.

SOROSPORIUM ELLISII, Winter, var. PROVINCIALIS, *n. var.* In inflorescence of *Andropogon provincialis.* Saline County, Mo. (Demetrio), and Custer County, Nebr. (Webber). Differs from the original speci-

mens on *Andropogon Virginicus*, described by Dr. Winter in Bull. Torr. Club, X p. 7, and distributed in N. A. F., 1099, in its more regular-shaped spores, with a thicker epispore and its larger spore glomerules subglobose, 35–150 μ, or oblong, 100–200 by 75–80 μ. The cylindrical mass of spores, also with an elongated bundle of fibers (the remains of the enveloping sheath)?, is inclosed in a light-colored membranaceous sack, which protrudes above, while in the typical form this sack is less distinct and is entirely concealed.

Sorosporium Everhartii, *n. s.* In florets of *Andropogon Virginicus*. Newfield, N. J., October (N. A. F., 2265 b.). Glomerules compact, opaque, 50–120 μ, in diameter, globose or oblong, composed of 100–300, or more closely-compacted spores, which do not easily separate and vary from subhyaline to brown and from subglobose 8–10 μ in diameter to oblong, 10–12 by 8–10 μ, with a nearly smooth epispore of medium thickness. The tips of the glumes in the affected florets become bleached, and open in a bifid manner, the lobes more or less reflexed, allowing the subcylindrical mass of spores to protrude. This differs from *S. Ellisii*, Winter in its smaller spores, more compact glomerules, and in attacking single florets instead of involving the entire inflorescence.

Didymosphæria denudata, *n. s.* On bark of dry dead oak limbs from which the epidermis had fallen off. Newfield, N. J., March, 1889. Perithecia scattered, ovate, suberumpent, minute (one-quarter millimeter), with comparatively thick membranaceous walls, the erumpent apex (about one-third part) roughish, black, with a papilliform ostiolum. Asci cylindrical, about 50 by 7 μ, abruptly contracted below into a short stipe-like base. Sporidia 1-seriate, elliptical, 1-septate, brown, 6–7 by 4 μ. This differs from *D. cupula*, E. & E., in its perithecia not collapsing and smaller, and in its smaller sporidia and shorter asci. It is found on the upper exposed side of the limb which is usually more or less bleached.

Ophionectria Everhartii, *n. s.* On old *Diatrype stigma* and on the decaying bark of oak limbs. Newfield, N. J., January, 1889. Gregarious, Perithecia ovate-globose, about one-sixth millimeter in diameter; granular-pruinose, except the rather acutely papilliform ostiolum dull dirty-yellow. Asci oblong-cylindrical, 75–80 by 12–14 μ, with rather indistinct paraphyses. Sporidia crowded-biseriate, fusoid, yellowish-hyaline, nucleate becoming faintly multiseptate, straight while lying in the asci, curved when free, 35–50 μ long and 3–3½ μ thick in the middle, gradually tapering towards each end.

Glœosporium paludosum, *n. s.* On leaves of *Peltandra Virginica*. Virginia, August, 1889. D. G. Fairchild; Wilmington, Del., October, 1889. A. Commons, No. 977. Spots amphigenous, orbicular, or elliptical, ½–1 centimeter in diameter or by confluence larger, dirty brown, subzonate; margin darker and subindefinite. Acervuli minute (65–75 μ), mostly erumpent above. Spores oblong, granular, 18–22 by 6–7 μ.

CERCOSPORA BRUNKII, *n. s.* On leaves of geranium (cult.). Brazos County, Tex., November, 1889. Prof. T. L. Brunk. Spots amphigenous, light-brownish or pale brick color, orbicular or oval, $\frac{3}{4}$–$2\frac{1}{4}$ millimeters in diameter, with a narrow, slightly raised, and rather darker border, which is more prominent on the lower side of the leaf. Hyphæ amphigenous, but more abundant below; pale brown, 90–200 by 3–5μ, subgeniculate, 2–5 septate, forming loose spreading tufts of 5–6 (rarely more). Conidia clavate-cylindrical, hyaline, multiseptate (5–20). 50–125μ. long, 3–4μ. thick (at the lower end). Differs from *C. geranii* in its darker hyphæ with more numerous septa, its larger multiseptate conidia and the raised border of the spots.

DENDRODOCHIUM SUBEFFUSUM, *n. s.* N. A. F. 394. On thallus of some foliaceous lichen on trunk of a pear tree. Farmington, N. Y., August, 1889. E. Brown, 134. Sporodochia subeffused, spreading over parts of thallus and apothecia, collected and condensed here and there into compact orange-red subapplanate masses about 1 millimeter in diameter. Basidia subulate, 25–35 by 2–3μ, sparingly branched. Conidia terminal, solitary, subglobose to ovate and elliptical hyaline 1–2 nucleate, 5–8 by $4\frac{1}{2}$–6μ.

SCORIOMYCES ANDERSONI. *n. s.* Under a decaying log of *Pinus ponderosa.* Belt Mountains, Montana. Altitude 6,500 feet. September, 1889. F. W. Anderson. Forms a waxy-yellow porous mass, 4–12 centimeters long, 2–4 centimeters thick and 2–4 centimeters wide, with an irregularly lobed outline and uneven, colliculose surface; lying among the decaying wood and humus and resembling somewhat a mass of collapsed honeycomb. It is made up principally of loosely compacted globose spores, 35–55μ in diameter and filled with coarse granular matter. Differs from *S. Cragini*, S. & E., in its more compact growth and larger spores. In *S. Cragini* they are only 18–20μ in diameter.

NEW FUNGI.

BY J. B. ELLIS AND B. D. HALSTED.

PHYLLOSTICTA MOLLUGINIS, *n. s.* On *Mollugo verticillata.* New Brunswick, N. J., October, 1889. Perithecia amphigenous, scattered, black, prominent, 80–100μ in diameter. Sporules oblong or elliptical-oblong, hyaline, 8–10 by 3–4 μ.

SEPTORIA RUDBECKIÆ, *n. s.* On leaves of *Rudbeckia laciniata*, northern New Jersey, September, 1889. Halsted. On *R. hirta*, Wilmington, Del., October, 1889. Commons, 1033. Spots conspicuous, of a weather-beaten or wood-colored brown, 2–4 millimeters in diameter, irregular, subangular in outline, with a definite darker border surrounded by a purplish stain. On *R. laciniata*, often one or two smaller white spots are included in the larger brown spots. On both hosts the spots are paler below. Perithecia epiphyllous, prominent, subacute, black, scat-

tered. Sporules filiform nearly straight, multinucleate, 30–60 by $1\frac{1}{2}$–2μ about the same as in *S. helianthi*, E. & K., to which this is closely allied.

Glœosporium cladosporioides, *n. s.* N. A. F., 2438. On living stems and leaves of *Hypericum mutilum*. Metuchen, N. J., July, 1889. Acervuli subcuticular, nearly black, about 35μ in diameter, superumpent, gregarious. Hyphæ fasciculate, continuous, toothed above, hyaline, becoming brown. Spores oblong, hyaline, faintly nucleolate, 10–14 by $3\frac{1}{2}$–$4\frac{1}{2}\mu$. Very injurious to the host plant.

Cylindrosporium iridis, *n. s.* On *Iris versicolor*. Iowa City, Iowa, June, 1887. A. S. Hitchcock. Acervuli very minute and very numerous, subcuticular, blackish, forming continuous series or strips between the nerves of the leaf for several centimeters in length, the exuded spores appearing like a white tomentum on the matrix. Spores acicular, 15–22 by 1μ. Hyphæ short, subhyaline, mostly toothed above, 8–10 by 2μ.

Zygodesmus pyrolæ, *n. s.* On petioles of *Pyrola rotundifolia*. New Brunswick, N. J., July, 1889. Forming a reddish-gray, thelephoroid layer enveloping the lower part of the petiole, which is slightly enlarged and distorted, and finally killed. Hyphæ, reddish-brown, much branched, the branches often issuing at a right angle, divided at their extremities into numerous short, obtuse arms bearing the subglobose, 8–10μ, rather coarsely spinulose-roughened, subhyaline, or reddish-brown conidia. The hyphæ are 3–4μ thick, and show the zygodesmoid joints very distinctly. The general appearance is something like that of *Calyptospora Gœppertiana*.

Cercospora lysimachiæ, *n. s.* N. A. F., 2475. On *Lysimachia stricta*. Jonesburgh, N. J., July, 1889. B. D. H. Spots, none; tufts, effused, covering the lower, less abundantly the upper surface of the leaf, which soon becomes of a dark red and dries up. Hyphæ in dense, spreading tufts, subundulate, subentire, reddish-brown, continuous, 40–50 by 4μ. Conidia, slender, obclavate, multinucleate (becoming septate), rusty-brown, 50–80 by 3μ. Under the hand lens this resembles *C. lythri*, West (specc. in Kunzes F. Sel., 594), but that has longer, slenderer, less densely tufted hyphæ and shorter, broader conidia.

Cercospora cleomis, *n. s.* On *Cleome pungens*. New Brunswick, N. J. Spots amphigenous, suborbicular, gray with a narrow dark border, 2–4 millimeters in diameter. Hyphæ amphigenous, loosely tufted, pale brown, septate, geniculate, 75–110 by $3\frac{1}{2}$–4μ. Conidia slender, hyaline, multiseptate, 75–100 by 3–$3\frac{1}{2}\mu$. Differs from *Cercospora capparidis*, Sacc. in the character of the spots and in its longer conidia and septate hyphæ.

Colletotrichum spinaciæ, *n. s.* On living leaves of spinach, which is much injured by it. Newark, N. J., February, 1890. Maculicolous. Spots round, dirty whitish or greenish, 2–4 millimeters in diameter, with a slightly raised border. Acervuli amphigenous, punctiform, 40–75 μ in diameter, clothed with a few (3–12) erect or spreading bristle-like hairs,

30–75 μ long and 4–4½ μ thick at the sub-bulbous base, subhyaline and subacute above, dark brown below, continuous (or faintly septate?). Conidia subfalcate-fusoid, hyaline, 2–4 nucleate, 14–20 by 2½–3 μ, ends subacute, basidia short.

NEW SPECIES OF LOUISIANA FUNGI.

By J. B. Ellis and A. B. Langlois.

Oidium obductum, *n. s.* On living leaves of young *Quercus* (*falcata*?). St. Martinsville, La., May, 1889. Langlois, 1708. Hypophyllous. Sterile hyphæ, slender (3–4 μ thick), sparingly septate, branched, loosely interwoven and with the large (35–50 by 18–22μ) barrel-shaped conidia forming a thin continuous or partially interrupted cinereous white layer over the greater part or often over the entire surface of the leaf. The concatenate conidia are formed by the constriction of the fertile hyphæ, rather abruptly contracted at each end and truncate.

Ovularia macluræ, *n. s.* On living leaves of *Maclura aurantiaca*. St. Martinsville. Hypophyllous on rusty brown round spots, 3–5 millimeters in diameter. Prostrate hyphæ branching, erect (fertile); hyphæ simple or sparingly branched above, slender, 15–22 by 2½–3 μ, continuous, hyaline. Conidia subcatenulate, oval, hyaline, continuous, 6–9 by 2½–3μ.

Dactylaria mucronulata, *n. s.* On decorticated and decaying wood of *Carya*. St. Martinsville, La., May, 1888. Langlois, No. 1220. Prostrate sterile hyphæ obsolete or wanting, fertile hyphæ erect, 35–40 by 3½ μ, continuous or with 1–2 faint septa and brown below, more or less angularly bent, and subhyaline above with terminal and lateral mucronulate teeth bearing the oblong 2-nucleate, hyaline, 8–10 by 2½–3 μ, conidia. The fertile hyphæ appear like a dull-purplish, velvet-like pubescence on the surface of the wood. *D. purpurella*, Sacc., has larger conidia and subspathulate-pointed hyphæ.

Coniosporium mycophilum, *n. s.* Parasitic on pileus of *Polyporus pergamenus*, (Fr.) and *Lentinus ursinus*, (Fr.). Louisiana, May, 1888. Langlois, 1306. Forms thin olive-black spots, scattered or confluent about 1 millimeter diameter. Conidia elliptical, olive-black, smooth, about 8 by 4μ.

Hormodendrum divaricatum, *n. s.* On rotten wood. St. Martin's County, La., May, 1888. Langlois, No. 1292. Forming loose, scattered tufts, fertile hyphæ, soon opaque, erect or spreading, 80–150 by 4–5μ; divaricately branched, the few branches often issuing at right angles, and like the upper portion of the main hyphæ articulated and constricted, separating into subelliptical, or lemon-shaped, opaque conidia, 7–12 by 6–7μ, the lower ones being the longer, the upper and terminal ones often subglobose.

Cercospora alternantheræ, *n. s.* On leaves of *Alternanthera achyrantha.* St. Martinsville, La. Langlois, No. 1430. Maculicolous. Spots round, 1–2 millimeters in diameter; dirty brown, with a whitish center and shaded brown border; hyphæ, 25–30 by 5μ, continuous, olivaceous, truncate above, arising from a tubercular base about 25μ in diameter; conidia obclavate, hyaline 1–3 septate, 65–80 by 3μ.

Cercospora thaliæ, *n. s.* N. A. F., 2426. On living and dead leaves of *Thalia dealbata.* St. Martinsville, La., October, 1889. Hyphæ amphigenous, very short, ovate, 6–8 by 5μ, olivaceous, mostly protruding in fascicles of 6–15 from the stomata of the leaf. Conidia cylindrical, olivaceous, 3–8 septate, 50–100 by 6–8μ. Ends rounded and obtuse. The hyphæ form dense, slaty-black, narrow, elongated patches 1½–2 millimeters wide and 3–5 millimeters long between the veinlets of the leaf in the same manner as in *C. zebrina*, Pass.

Macrosporium carotæ, *n. s.* On living leaves of *Daucus carota*, to which it is very injurious. St. Martinsville, La., June, 1888. Langois, No. 1327. Turning the leaves yellow, then brown black, and killing them entirely. Sterile hyphæ erect, at first simple, straight, brown, and septate, finally somewhat branched above. and 80–100μ high by 4–6μ thick. Conidia clavate, brown, 5–7 septate, with one or two of the upper cells divided longitudinally, 55–70 by 12–14μ, on long, slender (1½–2μ thick), permanent pedicels 80–110μ long.

Graphium squarrosum, *n. s.* On dead stems of *Sambucus.* St. Martinsville, La., July, 1888. Langlois, 1381. Cinereous gray, stripes ¾–1 millimeter high and about 20μ thick; erect, straight; composed of closely compacted fibers, with their hyaline free ends densely spiculiferous and spreading on all sides nearly at right angles below and obliquely upwards above, 8–12 by 2½–3μ, nearly straight or acutely and sharply bent, with their apices dentate and subobtuse. Conidia borne on the spiculiferous ends of the spreading fibers, ovate-oblong, hyaline, continuous, 5–7 by 2–2½ μ. Some of the conidia are larger (10–11 μ long) and 2–3 nucleate. It is uncertain whether these belong to the *Graphium* or are accidental.

Sphaeridium lacteum, *n. s.* On decaying herbaceous stems. St. Martinsville, La., January, 1888. Milk white, minute (¼–½ millimeter in diameter), contracted at base so as to appear briefly substipitate. Sporophore branched in a dendroid manner above, the branches moniliform, constricted, and separating into elliptical hyaline, 5 by 3μ, conidia.

Phyllosticta virens, *n. s.* On living leaves of *Quercus virens.* Louisiana, February, 1887. Langlois, No. 1070. Spots amphigenous, 1 centimeter in diameter, pale grayish-brown, subirregular, definitely limited by a slightly darker line. Perithecia partly erumpent, small (75–100μ.) Sporules oblong-elliptical or subovate elliptical or subfusoid, hyaline, 4–7 by 1½–2½μ. Differs from the other species on oak leaves in the character of the spots and size of the sporules.

VERMICULARIA DISCOIDEA, *n. s.* On dead culms of *Panicum proliferum.* Pointe a la Hache, La., February, 1887. Langlois, 1041. Perithecia for some time covered by the epidermis, discoid, ½–1 millimeter in diameter, orbicular or subelliptical, rather thickly and evenly covered with straight continuous black bristles 79–80 by 4–5μ, and subbulbous at base. Sporules falcate with attenuated acute ends, 3–4 nucleate, hyaline, 35–40 by 5μ. This seems to be quite distinct from any described species.

HAPLOSPORELLA TINGENS, *n. s.* On dead culms of *Andropogon muricatus.* St. Martinsville, La., March, 1889. Langlois, 1783. Perithecia subcespitose, 2–3 together or densely crowded, often seriately erumpent, becoming nearly superficial, conical, about one-third millimeter in diameter and one-half millimeter high. Sporules oblong-elliptical, 18–20 by 9–11μ. The culm is tinged slaty-black within.

DIPLODIA BAMBUSÆ, *n. s.* On dead stems of *Bambusa.* Mostly near the nodes. Perithecia hemispheric one-third to one-half millimeter in diameter, papillate. Sporules elliptical, brown, 1–septate and slightly constricted, 15–20 by 8–10μ.

DIPLODIA CUCURBITACEÆ, *n. s.* On dead pumpkin-vines. Pointe a la Hache, La., March, 1887. Langlois, No. 1049. Perithecia innate-erumpent scattered, their apices projecting and covered with the blackened epidermis. Sporules elliptical, brown, 1 septate, 20–25 by 10–12μ.

BOTRYODIPLODIA VARIANS, *n. s.* On dead limbs of *Lagerstrœmia.* St. Martinsville, La., January, 1889. Langlois, 1784. Perithecia erumpent superficial, solitary, oftener connate in clusters of 2–4 or more, conical, rough except the obtusely conic ostiolum, about one-half millimeter in diameter and a little more than that in height. Sporules elliptical, brown mostly continuous, some of them 1–septate, not constricted, 15–22 by 8–11μ. This may be the *Diplodia lagerstrœmiæ*, Speg., but that is said to have "sublenticular" perithecia only 200–250μ in diameter.

HENDERSONIA TINI, *n. s.* On dead spots in living leaves of *Viburnum tinus.* Lafayette, La., December, 1887. Spots large (2–3 centimeters), cinereous with a purplish-red border. Perithecia amphigenous, punctiform, innate-erumpent. Sporules fusoid, nucleolate, nearly straight, pale straw-yellow, 22–27 by 2½μ. Approaches *Septoria.* Probably the stylosporous stage of *Leptosphaeria tini*, E. & E.

PROSTHEMIELLA HYSTERIOIDES, *n. s.* On decorticated wood of *Salix nigra.* Near New Orleans, La., September, 1886. Langlois, 1792. Acervuli scattered, minute, punctiform or hysteriiform, covered above by a spurious perithecium, tinging the wood of a reddish color. Conidia in threes, cylindrical, hyaline, nucleate and imperfectly 5–6–septate, 30–35 by 1½μ, arising from short cylindrical basidia.

REVIEWS OF RECENT LITERATURE.

GIARD, ALFRED. *Sur quelques types remarquables de champignons entomophytes.* Bulletin Scientifique de la France et de la Belgique, 1889; pp. 197–224. Three plates.

This articles comprises a series of notes on a number of species of entomogenous fungi the greater part of which have already been published in a communication to the Société de Biologie, and which are here republished in a fuller form and with the addition of notes.

Of the nine species mentioned eight are species named and described by himself, and four of these represent new genera. Over half of the article is devoted to the three species *Entomophthora saccharina*, Giard, *E. plusiæ*, Giard, and *E. calliphoræ*, Giard, all of which are illustrated. He has made many trials in germinating both the resting spores and conidia of *E. saccharina* and finds that the latter lose their power of germination very rapidly and by September 1 it is impossible to infect insects with them; the resting spores would not germinate either in the insects or any artificial substratum, and moreover, before spring the bodies of the infested insects containing the resting spores had become covered with the sand of the dune on which he found them. He does not attempt to answer the question as to what becomes of the resting spores or how the caterpillars are infected in the spring.

E. plusiæ came to the author's notice in 1888 on some caterpillars of Plusia gamma which were destroying a field of trefle and luzerne. He did not find the resting spores but thinks it possible that they may appear on the autumn generation of the insect, and suggests that it may be the conidial form of *E. megasperma.* Attempts to inoculate any form of Sylpha opaca failed entirely, but the author believes that the inoculation of Plusia is particularly favored by an Acridien which reproduces on the infested insects.

During the researches on *E. calliphoræ* two forms of resting spores were found, recalling both by this fact and a remarkable similarity of spores the *Basidiobolus ranarum* of Eidam. The infested Diptera were discovered to be filled with resting spores and Giard is inclined to think that the following is the history of the fungus. The resting spores are eaten with the Diptera by Batrachians. They germinate in the digestive tube and produce conidia and some resting spores on the excrementa. Here they are eaten by the Calliphora, in the bodies of which they produce resting spores incapable of germination without a change of host. The experiments necessary to demonstrate this hypothesis have not been made.

The other species described or noted are *E. forficulæ* on Forficula auricularia: *E. Fresenii*, Now., which he has transferred rrom the genus *Triplosporium* and considers as probably identical with *Neozygites aphidis*, Witz., *Chromostylium chrysorrheæ* Giard, *Epichlœa divisa*, Giard, *Halisaria gracilis*, Giard, and *Polyrhizium leptophyei*, Giard.

The article closes with some general observations, among which the following facts of general interest are brought out:

(1) The use of entomogenous fungi in combatting injurious insects can not be of any injury to man except as they may infect useful insects such as the silk-worm.

(2) No reliable means have yet been ascertained by which injurious insects can be combatted by *Entomophthoreæ.* The question is a more difficult one than has been supposed.—E. A. S.

MASSEE, GEORGE. *A Monograph of British Gastromycetes.* Annals of Botany, November, 1889, Vol. IV., No. XIII, pp. 1–103. Four double plates.

This monograph, which may well be used as a hand-book for collectors of British fungi, is also of interest to American students of this group.

The work contains a discussion of the group in general and of the families comprising it, which is much more readable than De Bary's description of the same as found in the translation of his Morphology and Biology of Fungi. There are also chapters on Affinities and Distribution. A table is added giving the entire list of genera, distinguishing the British ones and noting the entire number of species and numbers of British species.

Mr. Massee divides the *Gastromycetes* into the following families: *Hymenogastreæ*, *Sclerodermeæ*, *Nidularieæ*, *Podaxineæ*, *Lycoperdeæ*, and *Phalloideæ.* The first corresponds, as regards the genera included, almost exactly to Saccardo's descriptions of the same. He includes the genus *Sphanchnomyces* under *Hymenogaster*, and says that a specimen of *Pompholyx sapidum* found near Chichester is evidently a species of *Scleroderma.* He differs from Saccardo in considering the *Sclerodermeæ* as one of the primary divisions of the *Gastromycetes*, and includes in it the following genera: *Polygaster*, *Scleroderma*, *Polysaccum*, *Arachnion*, *Scoleciocarpus*, *Paurocotylis*, *Ciliciocarpus*, *Lycogalopsis*, *Glishroderma.* These are all included in Saccardo's sub-family *Sclerodermeæ* of the *Lycoperdeæ*, but do not comprise all of the genera that Saccardo assigns to the sub-family; the others are placed in the *Lycoperdeæ.*

Massee says that the *Sclerodermeæ* occupy an intermediate position between the *Hymenogastreæ* and *Lycoperdeæ*, differing from the former in not being subterranean and from the latter in the absence of the capillitium and the indehiscent peridium. The genera included in the *Nidularieæ* are the same as those of Saccardo's Sylloge.

In his table of genera he ranks the *Podaxineæ*, which Saccardo regards as a sub-family of the *Lycoperdeæ*, as a family of equal value with the latter. It contains no British genera, however. His *Lycoperdeæ*, therefore, include considerably fewer genera than Saccardo's family of the same name. He characterises it by the constant presence of a capillitium produced from the hyphæ of the trama or peridium and remaining mixed with the spores after the deliquesence of the tramal and hymenial elements. Winter's family *Tulastomei* is placed as a genus

(*Tulastoma*) under the *Lycoperdeæ.* Much attention is given in this, as in others of Mr. Massee's articles, to synonyms and references to literature, and a complete Bibliography is appended, besides the very full references in the description of species.

The plates are excellent, both from an artistic and a scientific point of view.—E. A. S.

WAGER, HAROLD W. T. *Observations on the Structure of the Nuclei in Peronospora parasitica, and on their behaviour during the formation of the Oospore.* Annals of Botany, November, 1889, pp. 127–146. One double plate.

The fact that even the general occurrence of nuclei in fungi has been and is disputed, and that only two observers have ever made any attempt to investigate the phenomena of karyokinesis, even where the presence of nuclei was unquestioned, renders this paper unusually interesting.

The best results were obtained by imbedding the material in paraffine and cutting ribbon sections with a Cambridge microtome. By means of this process, the details of which are given, nuclei were found and their division watched in every portion of the fungus.

In the hyphæ.—The nuclei are most numerous where the hyphæ appear to be completely full of protoplasm, and in well stained sections the chromatin can be seen to arrange itself into threads, which are arranged in the equatorial plane, and which finally separate into two groups, the divisions moving to the opposite poles of the nucleus. Neither the spindle nor the longitudinal splitting of the chromatic elements were observed.

In the oogonium and antheridium.—Large numbers of nuclei are present in both oogonia and antheridia; in the former they become arranged in a layer in the periplasm, and all, with those of the antheridium, pass simultaneously through the karyokinetic processes; two (or three?) of the nuclei of the oogonium then pass into the center, and a wall is formed, shutting out the periplasmic nuclei which rapidly divide into smaller ones. At the same time an antheridial tube is developed, into which some of the nuclei of the antheridium pass. Of these one probably passes into the oospore; the remainder seem to pass into the periplasm of the oogonium, when the antheridial tube becomes disorganized. The ripe oospore contains several nuclei, and its endo- and exo-spore are formed from the periplasm and nuclei contained in it.

In the gonidia.—The nuclei of the gonidia are larger than those of other portions of the fungus, and differ in structure. There are a large number in each spore, but neither their division nor their origin has been observed.—E. A. S.

WARD, H. MARSHALL. *Timber and Some of its Diseases.* 8mo., 295 pages. Macmillan & Co.

The author, in this little volume, although treating the subject in a somewhat popular way, will especially interest the readers of this

JOURNAL, by his descriptions of the various diseases to which our forest and fruit trees are subject. Of the thirteen chapters, seven are devoted to the descriptions of the modes of growth of specific fungi which have, from their abundance and destructive nature, attracted the attention of tree growers.

Those which receive considerable attention, are the following:

Trametes radiciperda, Htg., the principal cause of "wet rot" or "red rot" of timber; *Agaricus melleus*, Secr.; *Polyporus sulphureus*, Scop.; *P. vaporarius*, Krombh., and *Merulius lacrymans*, (Jacq.) Fr., causing conjointly "dry rot;" *Peziza Willkomii*, Htg., pathogenetically connected with the larch disease or "canker;" *Coleosporium senecionis*, (Fr.) Pers. (*Peridermium pini*) the cause of the "pine blister;" and *Phytophthora omnivora*, DBy., which produced the "damping off" of young seedlings. The author has endeavored in the descriptions of these diseases to put the whole matter in such language that those unacquainted with the terms of cryptogamic botany may understand, and has devoted a large portion of each chapter to the dangers from these parasites and the most reasonable methods of avoiding such.

While chapter IV, on the theories advanced to explain the ascent of water in tall trees, is perhaps too technical to harmonize well with the other chapters, it will be found one of the most interesting because it brings together in comparison for the first time in any English work, all the prominent theories, old and new, in regard to sap ascension in forest trees.

The well-known theory held by Sachs that the sap ascends through the substance of the cell walls by reason of an extraordinary activity inherent in imbibed fluid, the author is willing to abandon for Hartig's and Godlewskii's osmosis pressure theory which takes refuge in the respiration of protoplasm to furnish the lifting force. According to the views of these investigators the sap ascends by means of the tracheids of the alburnum, and is drawn or forced upwards by a periodic change which the adjacent cells of the medullary rays undergo, by reason of which they alternately absorb water from the tracheids below and expel it into those above.

The remarks upon the healing of wounds by occlusion contain many warnings against the habit altogether too common among fruit-growers and foresters, of allowing freshly broken or cut surfaces of growing trees to remain exposed to the dangers so imminent, from the hosts of parasitic fungi which only await such opportunity to gain a foothold in the tree. As might be expected, repeated references to the work of Hartig and other investigators are met with; but, throughout, the book is well worthy attention.—D. G. F.

SWINGLE, W. T. *A List of the Kansas Species of Peronosporaceæ.* Transactions of the Twentieth and Twenty-first Annual Meetings of the Kansas Academy of Science (1887–'88). Vol. XI, p. 63.

This State list, the largest one yet published we believe, containing 32 species of *Peronosporeæ*, a family acknowledged to flourish best in a

moist climate with frequent showers, is remarkable as coming from a place of scanty rain-fall and long summer droughts. The author adopts for his classification that first used by Schrœter and repeated by Berlese and De Toni in Saccardo's Sylloge Fungorum, giving for convenience translations of the descriptions of family, genera, and sub-genera.

Two new species, *Peronospora hedeomæ*, K. & S., *P. cynoglossi*, Burrill, and a new variety of the latter, *P. cynoglossi*, var. *echinospermi*, Swingle, are quite fully described; measurements of 100 conidia and 25 conidiophores being given to establish the authenticity of the variety. Although it is to be regretted that there are no remarks upon the relation of this family to the atmospheric humidity it is interesting to note that the author finds only the following species as passing the winter in seeding plants: *P. arenariæ*, var. *macrospora*, *P. Arthuri*, *P. corydalis*, *P. parasitica*, *P. hedeomæ*, and *P. candida.*

The reference to an examination of every specimen for oospores as well as the carefully prepared synonomy show the work to be of the highest order. One or two changes in the authorities of some of the common species may attract attention but will be found to be well supported by the law of priority, such as *Cystopus amaranti*, (Schw.) Berk and *Peronospora parasitica*, (Pers.) Fries.

The addition of the localities from whence specimens have been obtained together with other convenient helps make the paper a very valuable one to State collectors.—D. G. F.

INDEX TO NORTH AMERICAN MYCOLOGICAL LITERATURE.

By David G. Fairchild.*

1. Dudley, W. R. Notes on investigations now in progress (with figures). Second Annual Report of Cornell Ag. Ex. Sta., 1889. Issued February 15, 1890. I. The onion mold (*Peronospora Schleideniana*, DBy.). II. Anthracnose of currants (*Glœosporium ribis*, (Lib.) Mont. and Desm.). III. Leaf-blight of quince and pear (*Entomosporium maculatum*, Lév.)

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*In addition to the reviews of recent foreign articles as published in the past we propose in the future to give an index to the North American Mycological Literature, endeavoring so far as possible to bring the information down to the time each issue of the Journal goes to print. In order to facilitate the work we shall be greatly obliged if the botanists will give us notice of any articles of a mycological nature contributed by them to other than the current scientific publications; and also in giving such information to state the exact date of publication. As Experiment Station bulletins and annual reports are seldom dated exactly, it will be a great convenience if botanists will kindly state in sending their reports to us the time at which they were ready for distribution. The work will be in charge of Mr. David G. Fairchild to whom all publications and communications bearing upon the subject should be addressed.—B. T. G.

2. FARLOW, W. G. Poisonous action of *Clathrus columnatus*, Bosc. Botanical Gazette; Vol. XV, No. 2, p. 45. February, 1890. Issued March 5.

3. GALLOWAY, B. T. Fungous Diseases of Fruits and their Treatment. Colman's Rural World, March 13, 1890, an address to the Peninsula Horticultural Society, second annual meeting, Chestertown, Md.

4. HALSTED, B. D. Some Fungous Diseases of the Cranberry. Bulletin 64 of New Jersey Agricultural College Experiment Station, December 31, 1889. I. The Cranberry Gall Fungus (with figures). Discovery and history. Structure. Inspection of the bog. Related species of plants infested. Comparison of galls on differents hosts. Study of infested bog. Recommendations for combating the gall. A new and as yet undescribed species of the genus *Synchytrium* (*S. vaccinii*, Thomas) is found to be the cause of this peculiarly local and destructive disease and its structure and life history, so far as possible in one year's study, are carefully worked out. II. The Cranberry Scald (with figures). Distribution of the fungus. Description of microscopical characters. The results of the first year's investigation of this obscure and in New Jersey, at least, extremely destructive disease, in which the mycelial threads of a sphæriaceous fungus are traced from the soil of the bog up through the stem and branches to the leaves and fruit where they mature their reproductive bodies. Preliminary suggestions are given as to the possible lines of treatment.

5. Hollyhock Diseases (*Puccinia malvacearum*, Mont., and *Cercospora althæina*, Sacc). Garden and Forest. March 26, 1890, p. 158.

6. KEAN, ALEXANDER LIVINGSTON. The Lily Disease in Bermuda (with plate), Botanical Gazette; Vol. XV, No. 1, p. 8, January, 1890. Issued January 28, 1890. A carefully prepared description of the parasitism of a species of *Botrytis* identical with that described by H. Marshall Ward in Ann. Bot., November, 1888, as it appears in Bermuda upon *Lilium Harrisii*. The author suggests as a possible remedy for this threatening disease the planting of some other crop in alternate rows, which, with high and spreading foliage, will prevent the collection of dew upon the leaves, and thus check the fungus so dependent on moisture for its propagation.

7. SCRIBNER, F. L. Root-rot of the Vine (*Agaricus melleus*, Secr. and *Dematophora necatrix*, R. Hartig). Orchard and Garden, January, 1890, p. 12.

8. Black-spot of the Rose (*Actinonema rosæ*, (Lib.) Fr.). Orchard and Garden, March, 1890, p. 57.

9. SEYMOUR, A. B., and EARLE, F. S. Economic Fungi. Fascicle I. Cambridge, Mass. January 1, 1890. The first of a series of fascicles of fungi parasitic upon cultivated or noxious plants. In book form, $3.50; unbound, $3.

10. THAXTER, ROLAND. I. Smut of onions (*Urocystis cepulæ*, Frost), (with plates). Annual Report of the Connecticut Agricultural Experiment Station for 1889. Report of the Mycologist. Issued March 11. History; origin; general characters; distribution and severity; conditions influencing prevalence and increase; dissemination; retention of germinative power by spores; occurrence or non-occurrence in sets and seed onions; botanical history and relations; manner of infection; experiments for prevention; general precautions. A most admirable treatment of the disease in which the botanical history and origin as well as the practical points of inquiry are well worked out. As the fungus seems to enter the plant only beneath the ground all treatments of seedlings must be before they appear above the surface of the soil. Only powdered fungicides were applied, scattered along the drills and slightly mixed with the soil before the planting of the seed. Although the author is not warranted he believes from his tentative experiments in recommending the use of flowers of sulphur as a preventive of the disease, it appears to him at least a promising substance for that purpose; of much more value than powdered copper sulphate which prevents germination of the seed, or iron sulphate, and less expensive in cost and application than sodium sulphide. The cost with rows one foot apart when the fungicide composed of one part of flowers of sulphur mixed with an equal part of air-slaked lime is scattered evenly in the bottom of the drills and the seed planted almost directly upon it, will not exceed, exclusive of labor of application, 60 cents per acre. II. The onion mildew (*Peronospora Schleideni*, Ung.), *ibid.* III. The onion Macrosporium (*Macrosporium sarcinula*, Berk. var. *parasiticum*, Thüm.), (with figures), *ibid.* IV. The larger onion Macrosporium (*Macrosporium Porri*, Ell.), (with figures), *ibid.* V. The onion Vermicularia (*Vermicularia circinans*, Berk.), (with figures), *ibid.* VI. List of fungi parasitic upon members of the genus *Allium*, *ibid.* VII. Mildew of lima beans (*Phytophthora phaseoli*, Thaxter), (with figures), *ibid.*

11. ——— On some North American species of *Laboulbeniaceæ.* Proceedings of the American Academy of Arts and Sciences, pp. 5–14. March 15, 1890. A preliminary communication on American members of this order, to be supplemented by a more extended account; to form the second part of a proposed monograph of *Entomogenous* plants.

12. WEBBER, H. J. Uredinial Parasites. Am. Nat., Vol. XXIV, No. 277. January, 1890, pp. 75, 76.

13. ——— Peridial Cell Characters in the classification of the Uredineæ. Am. Nat., Vol. XXIV, No. 278. February, 1890, p. 177.

14. ——— Peculiar Uredineæ (with plate). Am. Nat., Vol. XXIV, No. 278. February, 1890, p. 178.